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Ser. 26321. d. $\frac{8}{1863-67}.$

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised to September 1863.)

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1863.

Price Sixpence.

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SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.

[*Important Alterations made since the last addition of the Directory are
printed in Italics.*]

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes,†

V. *The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science*

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100*l.* a year. (See § xiii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given :—

GROUP I.

- Subject 1, Practical Plane and Descriptive Geometry.
- „ 2, Mechanical and Machine Drawing.
- „ 3, Building Construction or Naval Architecture.

GROUP II.

- „ 1, Theoretical Mechanics.
- „ 2, Applied Mechanics.

GROUP III.

- „ 1, Acoustics, Light, and Heat.
- „ 2, Magnetism and Electricity.

GROUP IV.

- „ 1, Inorganic Chemistry.
- „ 2, Organic Chemistry.

GROUP V.

- „ 1, Geology.
- „ 2, Mineralogy.

GROUP VI.

- „ 1, Animal Physiology.
- „ 2, Zoology.

GROUP VII.

- „ 1, Vegetable Physiology and Economic Botany.
- „ 2, Systematic Botany.

GROUP VIII.

- „ 1, Mining.
- „ 2, Metallurgy.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers.
(See § xv., xviii., xix., xx., and xxi.)
2. Grants towards the purchase of apparatus, &c.
(See § xxiii.)
3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiv., xv., xvi., and xvii.) On the results of these examinations the payment on results is made to the teachers. (See § xv., xviii., xix., and xx.)

VIII. Examinations for certificates to teach any of the before-mentioned sciences are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. Certificates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he is certificated.

IX. Suitable premises, with firing, light, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less than five well known responsible persons

Examinations
for Teacher's
Certificates.

School Pre-
mises.

Local Com-
mittee.

must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. See Science Directory, pages 15 to 18.

Examination
of Classes
under Cer-
tificated
Teachers.

XI. The Science and Art Department holds, through the agency of each Local Committee, in May of each year, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. On the results of this examination the payments are made to certificated teachers. Application for it must be made to the Secretary of the Science and Art Department before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. *All registered Students of Science Classes under certificated teachers* (except Science certificated teachers) are eligible to receive Queen's prizes and Queen's medals under the conditions hereafter mentioned. (See § xv., xvi., and xvii.)

Examination
of other
Classes.

XII. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 15 to 18, Science Form, No. 88 a.) *If the class be for artisans [the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.*

Places of
Examination.

XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the

Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committee will not be insisted on at present.

XIV. Any persons whatever, whether Examination of other Students. taught by the certificated teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted. *These candidates, if artisans, are eligible to receive Queen's prizes and certificates of merit (see § xvi. and xviii.); if registered students in artisan classes, they are eligible to receive Queen's medals, Queen's prizes, and certificates of merit under the conditions mentioned in § xvi. and xvii.; and if middle class students to receive certificates of merit.*

XV. The results of the May examination are classified under the following Classification of Results. heads:—(1) first class, (2) second class, (3) third class, (4) honourable mention, (5) pass, and (6) failed. The names of the successful candidates, those under the first five heads, are published. The standard of attainment required may be raised from year to year. For the *Pass* it is only such as will justify the Examiner in reporting that the instruction

has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as honourable mention, or as 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st class are given Queen's prizes consisting of books chosen by the candidates from lists furnished for that purpose. These are unlimited in number, except that a student who has once received a 1st class Queen's prize cannot receive a prize in the same subject again. If such student should be again successful, his name will simply be recorded in the published list. To the 2nd and 3rd class certificates of merit recording the result of the examination are given.

Certificates
of Merit.

Queen's
Medals.

XVII. The Queen's medals are—one gold in each group, one silver, and two bronze in each subject for competition throughout the United Kingdom.

Only registered students of schools and classes under Local Committees (see § xi. and xii.) can obtain medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to
Teachers.

XVIII. The payments to the certificated teacher are as follows:—He receives 1*l.* for every student of the industrial classes who has received 40 lessons from him in the subject in which he is certificated, and passes in such subject of scientific instruction; 2*l.* for every one who is honourably mentioned; 3*l.*, 4*l.*, or 5*l.* for every one who takes a 3rd, 2nd, or 1st class. These students must have received 40 lessons at least from the teacher since the last examination at which payment

was claimed on their account. The 40 lessons need not necessarily be all given in one year, but may extend over a longer period. 5l. is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and *this, only, subject to the reductions entailed by § xix. and xx.* That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received 3l. for a 3rd class, he can only claim 2l. If the same pupil had previously taken a 2nd class the teacher could only claim 1l. on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

*XX. Payments are only made on the foregoing scale when they amount to not more than 60l. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively.**

XXI. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 19.)

Form of Claim
for Payment.

XXII. A school register according to an approved form must be kept, which will be examined by the Inspector on his visit, and must be sent to the Department when required, and approved before any payment can be made.

School
Register.

* Thus, 100, that is, 60 + 40, is reduced to 60 + 40 - $\frac{1}{4}$ of 40 = 60 + 30 = 90. 150, that is, 60 + 40 + 50 is reduced to 60 + 30 + 25 = 115.

Grants for
Apparatus.

XXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5% to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49.

Travelling
Expenses of
Teachers.

XXIV. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in
an Elementary
School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of
Elementary
School
Premises.

XXVI. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

XXVII. The certificated teacher of ^{Master with} an elementary school who has pupil-^{Pupil-teachers.} teachers to teach cannot receive payments on account of Science teaching, even if holding a Science certificate.

XXVIII. But certificated teachers ^{Masters without} of elementary schools receiving aid from ^{Pupil-teachers.} the Educational Department who have not pupil-teachers to teach have their time out of school-hours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

APPENDIX.

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT THE ROYAL SCHOOL OF MINES.

At the May 1864 examination the following Royal Exhibitions and Free Admissions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Two Royal Exhibitions of the value of 50*l.* per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination, viz.:—

To a 1st grade Queen's Prize, in any subject	-	-	9 marks.
To a 2nd " " "	-	-	7 "
To a 3rd " " "	-	-	5 "
To an honourable mention	-	-	3 "
To a pass	-	-	1 "

and in addition—

For a gold medal	-	-	18 "
For a silver medal	-	-	7 "
For a bronze medal	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions.

FREE ADMISSIONS.

2. Free admissions to the lectures at the School of Mines.

A free admission is granted to any person who takes a gold medal in the May examination.

There are, in addition, the following Scholarships attached to the School—

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 30*l.* each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 15*l.* each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 25*l.* to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.

- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
 - c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
 - e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artisans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 40 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL OR CLASS.

We the undersigned,

- [1. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
2. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
3. It is absolutely necessary that at least two such responsible persons should agree to act.
4. The Committee must consist of a Chairman, Secretary, and at least three other Members.
5. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
6. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
7. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers.

the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—3*l.* for the duties connected with any Science school or class consisting of 5 or more pupils which is examined, and 1*l.* in addition for each further day's examination held. The Secretary must be a member of the Committee; the requirements in s. 1 apply equally to him.

8. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed.

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2*s.* 6*d.* may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	OCCUPATION.
 <i>Chairman.</i>		
 <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 88 a.

South Kensington, August 1863

**LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.**

- This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

**AN ACCOUNT OF TRAVELLING AND PERSONAL EXPENSES DISBURSED AND CHARGED
BY**

Thomas Jones,
From the *2nd* January 1860, to the *4th* January 1860.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £

Thomas Jones.
[Name and title of officer to be specified.]
Teacher of Chemistry in School of Manchester.

Date upon which the services were Performed.	In this column must be stated the services on account of which the journeys were performed, and the details of the expenses incurred.	TOTAL AMOUNT.
1860.	<i>To attend examination in Chemistry held at South Kensington on 3rd January 1860.</i>	
2nd January.	<i>Railway fare from Manchester to London (and Class) - 1 4 0</i>	
3rd January.	<i>Omnibus fare to and from Euston Square and South Kensington - 0 1 0</i>	
4th January.	<i>Railway fare from London to Manchester - 1 4 0</i>	
	<i>2 days' personal allowance at 10s. - - - - -</i>	<i>2 9 0</i>
		<i>4 0 0</i>
		<i>3 9 0</i>

NOTE.—Should the successful candidate live in London or near enough to get home at night, he is only to be allowed ss. per diem besides his travelling expenses.

Examined and approved,

Secretary.

Received this _____ day of _____ 18 _____, the sum of _____ pounds
_____ shillings and _____ pence in payment of the above amount.

£ _____

SCIENCE FORM No. 51.

Application from _____ Science Teacher in _____
 School or Institution at _____ for payment.

SIR,

BEING certificated in the subjects of science for teaching which the following claim is made, I request that the sum of £ _____ being the allowance for the year ended _____ 186 , according to the regulations, on the students named below, may be paid to me ; and I append certificates from the Committee of Management that the conditions upon which the allowance is authorized have been duly fulfilled.

On behalf of the Committee of Management of this School, We do hereby certify :—

- (1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .
- (2). That he has given the following Students at least 40 Lessons during the year, or since the last examination at which payment was claimed on their account.
- (3). That the under-mentioned students are *artizans or operatives* * in the receipt of weekly wages, or their children not earning their own livelihood.

Secretary.

Two members
of
Committee.

NAMES OF PASSED ARTISAN OR OPERATIVE STUDENTS.

N.B.—These must be arranged alphabetically in each subject, the name of the subject being placed at the head of each list of names.

Surname. Christian name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.	Highest position in same Subject at any previous Examination.
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
&c.	&c.			

* Should the Teacher have instructed any Students who may fairly be considered to belong to the artisan or operative class, but whose wages are paid at longer intervals than a week, the claims on their account must be made by the Committee of the School on the form on page 18, when they will be considered on their merits.

On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _____ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the operative classes. We certify :—

- (1). That he has given them forty (40) lessons at least during the year, or since the last examination at which payment was claimed on their account.
- (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
- (3). That the following particulars on which the Teacher grounds his application are correct.

 _____ } Two mem-
 _____ } bers of
 _____ } Committee.

NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES.

N.B.—These must be arranged alphabetically in each subject, the name of the subject being placed at the head of each list of names.

Surname. Christian name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.	Highest position in same subject at any previous Examination.
1. _____	_____	_____	_____	_____
2. _____	_____	_____	_____	_____
3. _____	_____	_____	_____	_____
4. _____	_____	_____	_____	_____
5. _____	_____	_____	_____	_____
6. _____	_____	_____	_____	_____
7. _____	_____	_____	_____	_____
8. _____	_____	_____	_____	_____
9. _____	_____	_____	_____	_____
10. _____	_____	_____	_____	_____
&c. &c.	_____	_____	_____	_____

I am, Sir,

Your obedient Servant,

Signature of Master _____.

The Secretary,
 Science and Art Department.

(The following particulars will be filled up at South Kensington).

Examined and found correct to the extent of _____
 _____ day of _____ 186
Approved _____ day of _____ 186

CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS, &c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES (TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),* IN PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality,

* Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditional that is, the Department will aid them to the extent of 5*l.*

and moderate in price. My Lords have therefore laid down the following rules and conditions:—

“1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

“2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

“3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard.”

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

No. 1 application to be filled in by Requisitionist, with full particulars.

	Male	Female	
Having _____			(*) Pupils (Artizans or Operatives) of the Science Class.
(*) Erase the words that do not apply.			
and _____			(*) Scholars or Members of Poor School or Mechanics Institute.
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—
To be forwarded to _____
per _____ at _____

Dated this _____ day of _____ 186 .
Signature of Requisitionist.

2. Requisition sent to M _____ day of _____ 186 . Agent.
this _____ and authority given for the supply of Articles to the extent _____
of _____
Net Sum

No. 2 to be filled in by the Department.

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186 .
Articles (Retail Price) £
Deduct as above, _____
Aid by Department
Add, for packing
Total to be paid by Requisitionist

No. 3 to be filled in by agent on transmission of the invoice.

4. Amount £ _____ received from schools this _____ day of _____ 186 . Agent.

Nos. 4 and 5 to be filled in by agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 . Agent.

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 . Requisitionist.

No. 6 to be filled in by Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They must also be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided by the Committee for the use of candidates.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,* who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day fixed for the examination.

7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee. No candidate may on any account be admitted after 7.30 p.m.

8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

9. When the candidates are seated and the papers given out, the Committee will see that the candidates *commence* by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

10. Candidates must on no account bring anything with them into the examination room,† except pens and pencils. No scribbling paper or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in

* When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

† Except in the drawing examination, when drawing instruments are allowed.

the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.

NOTE.—Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply especially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

13. The examination papers being given out no candidate must be allowed to return after having once left the room.* On a candidate leaving the room his papers must be taken up.

14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures, _____

* It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFICATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated, but are of as practical a nature as possible in the subjects of which the outlines are here indicated.

The examination is both by paper and *viva voce*, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, and *not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

Any certificate obtained at the examination may be raised, by re-examination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2*d.* each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

- | | | |
|----------|------------------------------------|-----------------------------------|
| Group I. | - Geometrical Drawing, &c. | Prof. T. Bradley. |
| " | II. - Mechanical Physics | - Rev. B. M. Cowie, M.A. |
| " | III. - Experimental Physics | - Prof. Tyndall, F.R.S. |
| " | IV. - Chemistry | - Prof. Hofmann, F.R.S. |
| " | V. - Geology | - Prof. Ramsay, F.R.S. |
| " | Mineralogy, &c. | - Prof. W. W. Smyth, M.A., F.R.S. |
| " | VI. - Zoology | - Prof. Huxley, F.R.S. |
| " | VII. Botany | - Edwin Lankester, M.D., F.R.S. |
| | Navigation and Nautical Astronomy. | J. Riddle, F.R.A.S. |
| | Physical Geography | - Dr. G. Kinkel, F.R.G.S. |

A Second Course has been delivered, of which the following have been published:—

- | | | | |
|-------------|---|-------------------------------|----------------|
| Lecture I. | - Vegetable Physiology and Economic Botany. | Edwin Lankester, M.D., F.R.S. | 3rd February. |
| Lecture II. | Mechanical Physics | Rev. B. M. Cowie, B.D. | 10th February. |
| Lecture IV. | Mining | W. W. Smyth, M.A., F.R.S. | 24th February. |

SYLLABUS.

GROUP I.

PRACTICAL PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL AND MACHINE DRAWING, AND BUILDING CONSTRUCTION.

This group consists of three subjects, viz.,—(first subject) Practical Plane, and Descriptive Geometry. (Second subject) Mechanical and Machine Drawing. (Third subject) Building Construction. And it is open to the candidate, to pass in either of the subjects alone, or in all, but a teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens, and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* and the *vernier* subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.
6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 \pm b^2}$, &c.
7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term *projection*, and of the necessity for it, in order to express graphically, on a surface, *solids* of any kind; the distinction between *orthographic* and *perspective projections*; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

Why the projections, of any solid consisting of a combination of geometric forms, on two or three *co-ordinate planes* are necessary to show the form and dimensions of that solid.

Meaning of the terms *plan*, *elevation*, *profile*, *section*. The principle of the representation of *surfaces* by the projections of their generators, or of equi-distant horizontal sections termed *contours*. The direction and inclination of an indefinitely extended plane given by its contours, or by its *traces* on any two co-ordinate planes.

These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.

A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—

1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.

2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.
3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artizan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed *Stereotomy*, and better and more significantly in French, "*Coupe de pierres*."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "*Geometry, Plane, Solid, and Spherical*" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry.

Text-Books for Practical Plane Geometry.—Bradley's *Geometrical Drawing*; Burchett's *Practical Geometry*; *Practical Geometry, Linear Perspective and Projection* (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's *Geometrical Drawing*; Hall's *Elements of Descriptive Geometry for Students in Engineering*.—Heather's *Descriptive Geometry*. Also the following French Works, which are

mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—*Elémens de Géométrie Descriptive*, par S. F. Lacroix ; *Traité de Géométrie Descriptive*, par Levebure de Fourcy ; *Nouveau Cours raisonné de Dessin Industriel*, par Armengaud, aîné, et Armengaud, jeune, et Amouroux ; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bonâ fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage ; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry ; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction ; the same description of attainments will be required.

GROUP II.**MECHANICAL PHYSICS.**

This group is taken under two subjects.

Subject I.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces:—Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject II.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended,—Willis's *Mechanism*; Baker's *Elements of Mechanism*; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics*; Goodeve's *Elements of Mechanism*.

GROUP III.

EXPERIMENTAL PHYSICS.

This group is taken under two subjects.

Subject I.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject II.—Magnetism and Electricity.*Magnetism.*

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books.—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

GROUP IV.

CHEMISTRY, INORGANIC AND ORGANIC.

This group is taken under two subjects.

Subject I.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: *Oxygen*. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of carbonate of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese, *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.

Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.

Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Watch glasses.
Metal filter stand.	Porcelain crucible.
Wash bottle containing distilled water.	Triangles.
Spirit lamp.	Test tube cleaner.
Black blowpipe.	Platinum wire and foil.
Charcoal for blowpipe experiments.	Funnels.
Iron spoon.	Cut filters.
Tongs.	Sulphuretted hydrogen apparatus.
Pestle and mortar.	Platinum crucible.
Porcelain dishes.	Hera path's blowpipe.
	Stirring rods.

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Sulphate of potassium.
Hydrochloric acid.	Sulphate of magnesium.
Nitric acid.	Chromate of potassium.
Hydrosulphuric acid.	Oxalic acid.
Potassa.	Tartaric acid.
Ammonia.	Acetic acid.
Chloride of ammonium.	Hydrofluosilicic acid.
Sulphide of ammonium.	Oxalate of ammonium.
Carbonate of ammonium.	Acetate of lead.
Phosphate of sodium.	Sesquichloride of iron.
Chloride of barium.	Ferrocyanide of potassium.
Chloride of calcium.	Chloride of platinum.
Lime water.	Nitrate of silver.
Sulphate of calcium.	

In the solid state.

Carbonate of sodium.	Lime.
Nitrate of potassium.	Sulphate of iron.
Cyanide of potassium.	Blue and red litmus paper.
Borax.	

Subject II.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books. — Graham's *Elements of Chemistry*, Miller's *System of Chemistry*, Fownes' *Manual of Chemistry*, Gregory's *Outlines of Chemistry*, Abel and Bloxam's *Handbook of Chemistry*, Galloway's *Qualitative Analysis*.

GROUP V.

GEOLOGY AND MINERALOGY.

This group is taken under two subjects.

Subject I.—Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.
3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.
4. Volcanoes and volcanic phenomena.
5. The theory of central heat.
6. Elevation and depression of land.
7. The ordinary mineral substances that enter into the composition of rocks.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.
2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-stones, limestones, and marbles.
3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.

4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.
 5. The new red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits, rock salt, and brine springs.
 6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.
 7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.
 8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.
 9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.
 10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
 11. Crag. Its subdivisions, chief fossils, phosphatic remains.
 12. Disturbance and denudation of strata.
 13. Unconformities, faults, and fractures.
 14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
 15. Water-bearing strata, and underground drainage. Artesian and other wells.
 16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.
 17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.
 18. The occurrence of stream tin, gold, &c., in superficial detritus.
 19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.
- Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*.

Subject II.—Mineralogy.

- a. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- b. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- c. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- d. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and

specific gravity : 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.

- e. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- f. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.
- g. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London, 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "Circle of the Sciences." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood on the *Metaliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

GROUP VI.

ANIMAL PHYSIOLOGY AND ZOOLOGY.

This group is taken under two subjects.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Subject I.—Animal Physiology.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death:—1st, as a part of life; *e.g.* moulting, shedding of skin and teeth. 2nd, as opposed to life; *e.g.* sloughing and mortification.

General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fetus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject II.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms*, *classes*, and *orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animals and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia*, *Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. Asexual multiplication as exhibited by these creatures. Types—*Hydra*, *Sertularia*, *Plumularia*, *Actinia*, *Corallium*, *Fungia*, *Oculina*.

iii. Starfishes, sea urchins, and *Holothurie*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster*, *Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lumbricus*, *Hirudo*, *Distoma*, *Tenia*, *Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Libellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells"

(*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodilus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*, *Cervus*, *Bos*, *Ovis*, *Felis*, *Phoca*, *Phocæna*, *Dasypus*, *Halmaturus*, *Ornithorhynchus*.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's *Animal Physiology*, Bohn, 1859; Dr. Kirke's *Manual*; Andrew Combe's *Physiology applied to Health and Education*. For Zoology.—Dallas's *Natural History of Animals*; Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Green's *Manual of the Protozoa*.

GROUP VII.**BOTANY.**

This group is taken under two subjects.

Subject I.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.
11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafoetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject II.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Algæ*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpacæ*, *Cannabinacæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*.
16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
18. *Labiataæ*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.

2. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellateæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbelliferae*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Aithusa*, *Oenanthe*, *Critthum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Cruciferae*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alliaria*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

GROUP VIII.

MINING AND METALLURGY.

This group is taken under two subjects.

Subject I.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramping, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines, to which they are applied. Hydraulic machines; construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jiggling, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's Report on Cornwall and Devon. *Greenwell's Treatise on Mine-Engineering.* *Dunn on the Winning and Working of Collieries.* *Hedley on Colliery Working and Ventilation.* Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines.* Reports of H.M. Inspectors of Coal Mines. *Transactions of the Northern Institute of Mining Engineers.*

Subject II.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

LIST OF SCIENCE SCHOOLS AND CLASSES.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruction in 1882-3.	Subjects taught and No. in each Class in 1882-3.
Aberdeen	Mechanics Institution.	Prof. Brazier, Dr. Beveridge, D. Mayer.	J. Sinclair	Science School, Aberdeen.	66	15 Th. & Ap. Mec. 30 Chem. 27 Botany.
Accrington	do.	H. P. Meaden	H. G. Duffield	Christ Church Street, Accrington.	19	19 In. Chem. 14 Or. Chem.
Accrington	New Jerusalem School.	H. P. Meaden	J. W. Kenyon	Manchester Road, Accrington.	25	25 Or. Chem.
Almondbury	Central School	G. Jarman	Rev. L. Jones	The Vicarage, Almondbury.	14	14 In. Chem. 3 Mineralogy.
Bacup	Mechanics Institution.	H. P. Meaden	J. Newbigging	Bacup	19	19 In. Chem.
Banbury	British School	J. H. Beale	J. Cadbury	Banbury	58	9 Geology. 47 A. Phy.
Banbury	Laboratory, 5, High Street.	T. Beesley	J. Cadbury	Banbury	20	20 Zoology. 20 In. Chem. 10 Or. Chem.
Belfast	National Model School.	F. Bardley	W. R. Molloy	10 College Square East, Belfast.	78	20 Ex. Ph. 61 Chemistry.
Belfast	Museum	R. Tate	J. T. Murphy	13 College Square East, Belfast.	84	63 In. & Or. Chem. 11 Phy. & Zool. 47 Botany.
Birmingham	Midland Institute.	W. M. Williams	T. Martineau	7 Cannon Street, Birmingham.	67	
Birmingham	School of Art	D. W. Raimbach	C. Laundry	20 Paradise Street, Birmingham.	31	31 Mec. Drawing.
Bolton	Bridge Street School.	T. Ward	G. Knowles	Tudor Villa, Heaton, near Bolton.	15	15 In. Chem.
Brimscombe	Science School	W. Vick	J. Beddus	Brimscombe	47	47 Chem.
Bristol	Trade School	T. Coomber, W. Rowden, H. Fulton.	J. Wilkson	Trade School, Bristol.	105	61 Geo. Draw. 41 Mec. Draw. 21 Build. Con. 30 Th. Mec. 33 App. Mec. 71 In. Chem. 12 Or. Chem. 19 Geology. 20 Mineralogy.
Burnley	Mechanics Institution and Grammar School.	L. Clement	J. Sutherland	Post Office, Burnley.	72	72 In. Chem. 16 Or. Chem.
Burnley	Church of England Literary Institution.	H. P. Meaden	B. W. Briggs	North Parade, Burnley.	16	16 In. Chem. 2 Or. Chem.
Calne	Mechanics Institution and Middle School.	J. Bownas	Rev. Canon Guthrie.	The Vicarage, Calne.	40	40 In. Chem.
Camborne						
Carrickfergus	Parochial School House.	R. Tate	W. Molony	Union Hall, Carrickfergus.	50	59 Geology. 50 Botany.
Chester						
Chippingcamden.	Boys School, Church Street.	W. Guin	Rev. J. Hamilton.	Campden, Gloucester.	17	17 An. Phy.
Crewe						
Crow's Nest						
Dedham	Literary Institute.	J. C. Clough	J. M. Rodwell	Dedham	6	6 Chem.
Drogheda	Mechanics Institute.	J. Dowling	P. E. Grey	Drogheda	44	32 In. Chem. 32 Or. Chem. 14 V. Phy. 14 S. Botany. 12 Metallurgy. 30 In. Chem.
Dudley	Mechanics Institute.	J. Jones	T. Wright	Wellington Road, Dudley.	30	
Glasgow	Secular School	J. Mayer	R. S. Cunliffe	21 Carlton Place, Glasgow.	102	26 Chem. 70 An. Phy. 52 Botany. 66 Metallurgy.
Glasgow	Andersonian University.	-	R. B. Smith	39 Garnet Hill, Glasgow.		

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under instruction in 1862-3.	Subjects taught and No. in each Class in 1862-3.
Gloucester	Blue Coat School	W. Jeffery	Rev. C. Crawley	Grey Friars, Gloucester.	35	35 Ac. L. & H. 24 Mag. & Elec. 24 Or. Chem.
Gunnis Lake	Working Man's College.	J. Noble	G. Gibb	Haley Hill, Halifax.	35	34 In. Chem. 18 Or. Chem.
Haslingden	The Institute	H. P. Meaden	J. Binns	Haslingden	19	15 Mag. & Elec. 14 In. Chem. 12 Or. Chem.
Hastings	Temperance Hall	T. Jones	Rev. W. W. Hume.	Mary Magdalen's Parsonage, St. Leonards-on-Sea.	21	21 Geo. Draw.
Helston	Proprietary School.	S. Crawley	B. M. Lingwood	Lyston Court, Hereford.	20	20 In. Chem. 2 Or. Chem.
Hereford	National School	J. Mellor	J. Fletcher	Hollingswood	24	24 Geo. Draw. 24 Mec. Draw. 24 Build. Const.
Huddersfield	Literary and Scientific Institution.	G. Jermain G. Tindall	G. W. Rhodes	30 Ramsden Street, Huddersfield.	15	15 In. Chem. 9 Or. Chem. 9 Geology. 9 An. Phy. 11 Zool.
Kinver	Science School	W. M. Packer	T. Bolton	Hyde House, near Stourbridge.	10	8 In. Chem. 3 An. Phys.
Leeds	Mechanics Institution.	G. Ward	B. Blake and J. Pickering.	Mechanics Institution, Leeds.	32	32 In. Chem.
Lisburne	Presbyterian School.	R. Tate	J. Millar	Market Square, Lisburn.	25	23 Zoology. 25 Botany.
Liskeard	Free Library, William Brown junior.	Dr. Collingwood. E. H. Birkenhead. E. Bowen N. Samuelson	J. Samuelson	Science School, William Brown Street, Liverpool.	139	74 Ac. L. & Heat. 74 Mag. & Elec. 23 In. Chem. 37 Geology. 37 Mineralogy. 18 Zoology. 18 Botany.
Liverpool						
London:						
Bethnal Green	Birkbeck School	R. W. Pike			62	43 Ex. Phys. 40 An. Phy.
Chancery Lane.	London Mechanics Institution.	J. C. Douglas	J. Pearsall		50	30 Mag. & Elec. 30 An. Phy.
Charterhouse	Working Men's College.	A. Grurgeon	G. Phillipson T. Shorter	45 Great Ormond Street.	11	11 V. Phy.
Great Ormond Street.	Holly Lodge, West Hill.	M. C. Coote	Rev. J. B. Dyne	School House, Highgate, N.	19	11 S. Botany. 19 V. Phy.
Highgate	Public School, Lower Road.	J. Howard			60	40 Ex. Phys. 24 Chem. 40 An. Phy.
Islington	Sailors' Home	W. Stockton R. Strachan			31	6 Geo. Draw. 12 Th. Mec. 12 Ap. Mec. 6 Ac. L. & H. 6 Mag. & Elec. 6 In. Chem.
Poplar						63 Geo. Draw.
Kingsland	British School Room.	R. Bithell			58	
Kingsland	Birkbeck School	J. Buntz	G. Bond	3 Walcot Place, Hackney, N.E.	110	110 Ex. Phys. 110 Chem. 110 Phy. & Zool.
Lostwithiel	Modern Free School.	J. Chadwick	J. Jackson	97 Great King Street, Macclesfield.	33	33 In. Chem.
Macclesfield	Christ Church School.	G. J. Snelus	J. Brooker	54 Mill Street, Macclesfield.	30	30 In. Chem.
Manchester	Mechanics Institution.	J. Angell J. Mellor	E. Simpson	Mechanics Institution, Manchester.	145	100 Geo. Draw. 45 An. Phy.
Manchester	Class Rooms, 68 Corporation Street.	F. Hudson	T. Gregory	Victoria Park, Manchester.	35	15 M. Phy. 35 In. Chem. 30 Or. Chem.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under instruction in 1862-3.	Subjects taught and No. in each Class in 1862-3.
Marazion						
Margate			J. Boulden	Dane Hill House, Margate.		
Metropolitan see London.						
Middlesbro'		W. Crossley	W. Taylor	Middlesbro'	17	17 In. Chem. 17 Or. Chem.
Middleton	Long Street	G. W. Wheeler	Rev. J. W. Walker.	Middleton	14	6 Ac. L. & H. 12 Mag. & Elec. 15 In. Chem.
Nelston in Marsden.	Mechanics Institution.	L. Clement	J. Sutherland	Post Office, Burnley.	15	
Netherton	Mechanics Institution.	B. Bentley	G. W. Rhodes	30 Ramsden Street, Huddersfield.	12	12 In. Chem.
Northornesby	Class Room, Smeaton Lane.	R. Weatherill	Rev. V. A. Moyle.	Northornesby, Middlesbro'-on-Tees.	10	10 In. Chem.
Nottingham	Mechanics Institution.	Dr. T. Wilson	L. Liepman	College Villa, Nottingham.	63	63 In. Chem.
Oldham	Parish Church Schools.	J. Mellor	Rev. D. M. Alexander.	Oldham	95	95 Geo. Draw. 95 Mec. Draw. 95 Build. Con. 11 In. Chem.
Padiham	Working Men's Trade Hall.	L. Clement	J. Sutherland	Post Office, Burnley.	11	
Painswick	Girls National School Rooms.	M. Pullen	Rev. W. Molesworth.	Painswick	20	18 Mag. & Elec. 20 In. Chem.
Pendleton	Mechanics Institution.	W. Hudson	T. Gregory	Victoria Park, Manchester.	13	13 Geo. Draw. 13 Mec. Draw. 13 Build. Con. 13 In. Chem.
Queenshead	National School	J. Halliday	G. Turner	Queenshead, near Halifax.	13	13 In. Chem.
Rawtenstall	Mechanics Institution.	H. P. Meaden			14	14 In. Chem.
Redruth		C. Twite	A. Paul	Camborne		
St. Agnes						
St. Day						
St. Ives						
St. Leonards	Improvement Society's Rooms.	T. Jones	Rev. W. W. Hume.	Mary Magdalen's Parsonage, St. Leonard's-on-Sea.	included with Hastings.	
St. Just						
Salford	Working Men's College.	C. O'Neil	W. Noare	Town Hall, Salford.	18	18 In. Chem.
Slough	Mechanics Institution.	J. Dorrell	J. Chapman	Upton Grove, Slough.	29	29 Geo. Draw.
Stockport	do.	W. Hudson	T. Gregory	Victoria Park, Manchester.	26	26 Geo. Draw. 26 Mec. Draw. 26 Build. Con. 32 Chemistry. 27 Geology. 34 An. Phy.
Stroud	Lecture Hall of Mutual Improvement Society.	M. Pullen W. Vick D. Paine	S. T. Dudridge	Bowbridge, Stroud.	83	
Tandridge	Club Room	W. Brears	Rev. A. S. O'Callaghan.	Oxted	15	12 Mag. & Elec. 15 Geology.
Tintwistle	National School	W. Cooper	P. Taylor	Tintwistle, Hadfield, Manchester.	5	5 Th. Mec.
Tywardreath						
Upton St. Leonards.	The School Room	W. J. Davies.	Rev. J. Betts	Upton St. Leonards.	29	22 Mag. & Elec. 8 V. Phy.
Wednesbury	Mechanics Institution.	John Jones	C. T. Britten	Wednesbury	16	16 In. Chem.
Wigan	Mechanics Institution.	E. H. Birkenhead.	M. W. Pearce	Wigan	51	37 In. Chem. 15 Geology. 14 Mining 21 Geo. Draw.
Windsor	Working Man's Institute.	J. H. Hetherington.	J. H. Pasmore	9 William Street, Windsor.	21	
Wolverhampton	Christian Institution.	John Jones	J. N. Langley	Mowbray House, Wolverhampton.	15	15 In. Chem.
Woolwich	Mechanics Institution Royal Arsenal.	Thos. Jones	R. McGrath	Royal Gun Factories, Woolwich.	51	51 Geo. Draw. 55 Mec. Draw.

TABLE of HONORARY DIPLOMAS granted without EXAMINATION.

Name.	Address.	Group I. Geometrical Drawing, &c.			Group II. Mechanical Physics.		Group III. Experi- mental Physics.		Group IV. Chemistry.		Group V. Geology and Miner- alogy.		Group VI. Animal Physiology and Zoology.		Group VII. Vegetable Physiology and Economic Botany.		Group VIII. Mining and Metallurgy.	
		Subject.			Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.	
		I.	II.	III.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Brasier, Professor	- Aberdeen -	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..
Collingwood, Dr.	- Liverpool -	..	..	..	..	..	..	..	..	..	..	..	1st	1st	..	..	..	..
Carter, B. B.	- Stroud, Gloucestershire -	..	..	..	..	..	..	..	..	..	..	..	1st	1st	..	..	..	..
Pepper, John H.	- Polytechnic Institute, Regent St., London -	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..

TABLE SHOWING CERTIFICATES HELD BY SCIENCE TEACHERS.

Revised by the Examination of November 1892.

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1899 came into operation.

Name.	Address.	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.	
		Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy.	
		I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Abbott, Joseph	Collegiate Institution, Liverpool	..	..	..	..	1st	1st	1st	2nd	..	..	..	..	..	..	..	..
Allread, Edwin	Training College, Battersea	..	..	..	..	1st	1st	2nd	2nd	..	..	..	..	..	..	..	..
Allott, James	National School, Ruabon, North Wales	..	..	..	..	1st	1st	3rd	2nd	..	..	..	..	..	..	..	..
Allen, William	Grammar School, Moulton, near Spalding	..	..	..	..	..	..	..	..	..	..	1st	..	..	..	..	..
Angell, John	Mechanics' Institute, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arthey, William	Wilde's Endowed School, Lowestoft	..	..	..	..	..	..	3rd	2nd	..	..	..	..	..	..	..	..
Atkins, Edward	St. Martin's School, Leicester	..	..	1st	3rd	..	..	2nd	1st	..	..	..	..	..	..	..	..
Atkins, George	Laxton Street School, Leicester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bailey, Edward J.	St. Mark's College, Chelsea	..	..	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Baldock, John H.	55, St. James Road, Holloway	..	..	..	..	..	..	1st	1st	..	..	..	..	1st	..	..	..
Barret, E.	31, Gloucester Street, Regent's Park	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..
Barley, George C. T.	Beresford Villa, Amherst Road, N.	..	..	..	..	2nd	2nd	3rd	..	..	..	..	..	..	..	..	..
Beale, John H.	Science School, Banbury	..	..	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..
Beesley, Thomas	5, High Street, Banbury	..	..	..	..	2nd	3rd	1st	2nd	..	..	..	..	1st	..	..	..
Bentley, Buzi	Kirkheaton	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Berriman, John	Training College, Battersea	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Beveridge, Robert	2, Upperkirkgate, Aberdeen	..	..	..	..	..	..	..	..	..	..	1st	..	1st	..	..	..
Birkenhead, E. H.	Mining School, Wigan	..	..	..	..	1st	1st	2nd	2nd	..	..	1st	..	1st	..	1st	..
Bithell, Richard	Kingsland British School, Stoke Newington Road, N.	..	..	..	..	2nd	2nd	1st	..	..	..	..	..	2nd	..	..	..
Blackwell, C. A.	National School, Owsdon, nr. Bawtry	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Bleas, William	Training College, Westminster	..	..	..	..	..	..	2nd	2nd	..	..	..	..	..	..	..	..
Bocharoff, Alexis	17, Elton Street, Lower Broughton, Manchester.	..	..	..	..	..	..	2nd	2nd	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.	
		Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy.	
		I.	II.	III.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I.	II.	Subject.
Bowen, Edward	85, Boundary Lane, West Derby Road, Liverpool.	..	..	..	..	3rd	3rd	..	..	..	..	..	..	..	..	..	..
Bownas, John	The Green, Calne, Wilts	..	..	..	1st	..	..	2nd	..	..	..	..	..	..	..	..	..
Breakwell, William	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brears, William	Tandridge School, Godstone, Surrey	..	..	..	..	3rd	2nd	..	..	..	..	..	..	..	..	..	..
Briggs, James Alfred	Mechanics' Institution, Chancery Lane	..	..	..	..	2nd	2nd	..	..	..	..	..	..	..	..	..	..
Bright, William	17, Bute Street, Cromwell Lane, Brompton, S.W.	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Brown, Moses	Training College, Battersea	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Brown, W. J.	Training College, Battersea	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Burrehill, Samuel H.	Navigation School, Shadwell	..	..	..	..	2nd	3rd	..	..	..	..	..	..	..	..	..	..
Buckmaster, J. C.	St. John's Hill, Wandsworth	..	..	..	..	1st	2nd	1st	..	..	..	..	..	..	..	..	..
Burns, William	8, Newton Terrace, Rochester	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..	..
Burton, John	Training College, Westminster	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Cattell, Thomas E.	National School, Cottesmore, Oakham	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..	..
Causier, Jno. Wm.	13, Hindon Street, Pimlico	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chadwick, John	Modern Free School, Macclesfield	1st	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..
Chalk, Ellen M.	3, Heasman Terrace, Victoria Park	..	..	..	..	..	..	..	..	..	..	1st	..	..	..	..	..
Chalk, Frank	3, Heasman Terrace, Victoria Park, N.E.	..	..	..	..	..	..	2nd	..	..	..	2nd	..	..	..	..	..
Clapp, Elizabeth, M.A.	Birkbeck School, Kingsland	..	..	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..
Clark, Albert Chas.	National School, Salisbury	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Clement, Leonard	East Lancashire Union of Institutions, Burnley	..	..	..	..	1st	2nd	1st	..	..	..	..	..	1st	..	..	..
Clough, James C.	Grammar School, Dedham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cockman, Abraham	National School, Grantham	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Cotes, Ferdinand	9, Walpole Street, Chelsea	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Collins, John	Cathedral School, Manchester	..	..	..	..	3rd	3rd	..	..	..	..	2nd	..	..	..	..	..
Collins, Joseph H.	36, Denmark Grove, Barnsbury Park	..	..	..	..	..	..	3rd	2nd	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Group I. Geometrical Drawing. &c.			Group II. Mechanical Physics.		Group III. Experimental Physics.		Group IV. Chemistry.		Group V. Geology and Mineralogy.		Group VI. Animal Physiology and Zoology.		Group VII. Vegetable Physiology and Economic Botany.		Group VIII. Mining and Metallurgy.	
		Subject.			Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.	
		I.	II.	III.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Greenstreet, Wm. A.	Christ Church School, Chelsea	..	..	..	3rd	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Greenwood, Aaron T.	Training College, Westminster	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Grove, John W.	Green-coat School, Hertford	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grugson, Alfred	3, Radnor Terrace, Brownlow Rd., Dalston	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gunn, William	Chipping Campden, Gloucestershire	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Haight, Thomas R.	Training College, Westminster	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Halliday, John	Queenbury Schools, near Halifax	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Hands, Jonathan G.	Training College, Battersea	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Hancock, John	17, Riding House Street, Langham Place	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hargreaves, John	National School, Goldsboro', Knaresboro'	..	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Hetherington, J. H.	Windsor Road, Slough	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
High, William E.	Blue Coat School, Cirencester	1st	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Holckin, Tycho E.	9, Ashwell Street, Leicester	..	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Holt, George	Wesleyan Training College, Westminster	..	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Holdcroft, Herbert	Training College, Westminster	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Honey, Robert	Cowper House School, Huntingdon	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hough, Joseph	Wootersley Observatory, near Wolverhampton.	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Howard, John	Lower Ishington Public School, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hudson, Fearnside	68, Corporation Street, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hudson, Washington	Eagle Foundry, Manchester	..	..	2nd	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Hudson, J. Schofield	National School, Breckburn-morpeth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hudson, William	National School, Abedallery near Newport	..	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Hurst, Wm. F.	Middle School, Leicester	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Ives, Wm. Field	St. John's School, Limehouse	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jackson, Robert	St. Mark's College, Chelsea	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Group I.			Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.	
		Geometrical Drawing, &c.			Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy.	
		I.	II.	III.	Subject.	I.	II.	Subject.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I.	II.	Subject.
O'Neill, Charles	Working Men's College, Salford	..	..	..	..	..	..	2nd	1st	1st	..	..	2nd	..	..	..	..	..
Ormsby, Daniel C.	Free Church School, Jamestown, Dumbartonshire.	..	..	..	..	..	..	..	2nd	3rd	..	..	..	..	..	..	..	..
Packer, Matthew W.	National School, Kinver, Stourbridge	..	..	..	..	..	..	..	..	3rd	3rd	..	2nd	..	..	..	..	..
Pascoe, John	Green-coal School, Huddersfield	..	..	..	..	..	..	3rd	..	2nd	..	..	1st	..	..	..	..	..
Patticot, Isaac	Queenstead Schools, Halifax	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Pearce, Richard	Royal Institution, Truro	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Pearce, William	Maber Lodge, Portwood, Southampton	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Pearsall, T. J.	London Mechanics' Institution	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Pepper, Charles	St. Mark's College, Chelsea	..	3rd	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Perry, George W.	St. Michael's Schools, Pimlico	..	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..
Phillips, Harvey	5, Robert Street, Millford Haven	..	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..
Pike, Robert W.	Birkbeck Schools, Bethnal Green	..	..	..	..	..	..	2nd	1st	..	..	..	1st	..	..	..	..	..
Pitt, Robert	Charterhouse Boys' School	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Plant, John	Royal Museum, Peel Park, Salford	..	..	..	..	..	..	2nd	3rd	..	..	..	..	..	..	..	..	..
Pullen, Moses	National School, Painswick Stroud	2nd	..	..	..	2nd	3rd	..	..	..	..	..	..	..	..	..	..	..
Puckett, Joseph	14, Goldington Street, St. Pancras Road, London.	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Radford, Arthur	16, Sheffield Terrace, Campden Hill, W.	1st	1st	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Raimbach, David W.	School of Art, Birmingham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Redgrave, Gilbert E.	118, Hyde Park Gate South	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ricks, George	St. John's School, Portsea	..	..	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..
Ripley, Henry J.	Training College, Battersea	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Robertson, John	Middle Class School, Bagshot, Surrey	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Robertson, John	Milton Established Church Sessional Schools, Glasgow.	..	..	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..
Bowden, William	Trade School, Bristol	1st	1st	2nd	1st	2nd	2nd	2nd	..	..	2nd	1st	..	..	..	..	2nd	1st

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.	
		Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy.	
		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.	
		I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Twite, Charles	Miners' Association, Truro	..	..	..	..	2nd	..	3rd	3rd	3rd	2nd	..	..	..	..	2nd	..
Vick, William	National School, Camcross, Stroud	..	..	..	..	..	..	3rd	3rd	..	..	..	..	..	..	..	..
Waite, John	Darley Street School, Leeds	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Ward, Thomas	Wesleyan S. Bridge Street, Bolton	..	..	..	..	..	..	3rd	3rd	..	..	..	..	..	..	..	..
Ward, George	Mechanics' Institution, Leeds	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Warner, William	Training College, Battersea	..	..	..	..	3rd	..	2nd	..	..	..	..	..	..	..	..	..
Watkins, James	Grammar School, Deptford	..	..	..	..	..	..	3rd	..	..	2nd	..	..	..	..	..	..
Weatherill, Robert	Pennyman School, North Ormesby, Middlesex	..	..	..	..	..	..	3rd	2nd	..	..	..	..	..	..	..	..
Wheeler, G. H.	National School, Middleton, Manchester	..	..	..	..	1st	..	3rd	..	..	..	2nd	..	..	..	..	..
Wild, Robert	National School, Bromley, Middlesex	..	..	..	..	1st	..	2nd	..	..	..	..	..	..	..	..	..
Williams, John	St. Mark's College, Chelsea	..	..	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Williams, W. M.	Oak Alyn, near Wrexham, Denbighshire	..	..	..	..	1st	..	2nd	..	..	..	3rd	..	..	..	..	..
Wilson, Thomas	Derby Road, Nottingham	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Winney, William	Training College, Westminster	..	..	..	..	3rd	..	3rd	..	..	..	..	..	..	..	..	..
Winter, William	27, Ash Grove, Bradford, Yorkshire	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Wire, Alfred P.	Training College, Battersea	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Wood, C. H.	Pharmaceutical Society, Bloomsbury Sq.	..	..	..	..	..	..	1st	..	..	..	..	..	..	..	..	..
Wood, Charles S.	New Zealand	..	..	..	..	..	..	1st	2nd	1st	1st	..	..	..	..	1st	..
Wood, Edward	31, Richmond Place, Brighton	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..
Woodcock, Fred. W.	Grammar School, Boxworth	..	..	..	2nd	..	..	1st	3rd	..	..	..	..	2nd	..	..	..
Woodhead, William	166, Waverley Road, Edgehill, Liverpool	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..
Woodward, Chas. J.	Midland Institution, Birmingham	..	..	..	..	..	..	1st	..	..	..	..	2nd	..	..	..	..
Woollett, John	3, Millfield Place, Green Lanes, Stoke Newington	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..
Yates, Frederick	Pennfields, Wolverhampton	..	..	..	..	..	..	..	..	..	..	1st	..	..	..	..	..

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised to Sept. 1864.)

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1864.

Price Sixpence.

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SCIENCE AND ART DEPARTMENT OF THE
COMMITTEE OF COUNCIL ON EDUCATION,

CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, The Right Hon. the Earl GRANVILLE, K.G.

*Vice-President of the Committee of Council on Education, The Right Hon.
H. A. BRUCE, M.P.*

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* The letters S and A refer to the Science and Art Certificates taken.

SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.

[*Important Alterations made since the last addition of the Directory are
printed in Italics.*]

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes,†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100*l.* a year. (See § xiii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

GROUP I.

- Subject 1, Practical Plane and Descriptive Geometry.
- „ 2, Mechanical and Machine Drawing.
- „ 3, Building Construction or Naval Architecture.

GROUP II.

- „ 1, Theoretical Mechanics.
- „ 2, Applied Mechanics.

GROUP III.

- „ 1, Acoustics, Light, and Heat.
- „ 2, Magnetism and Electricity.

GROUP IV.

- „ 1, Inorganic Chemistry.
- „ 2, Organic Chemistry.

GROUP V.

- „ 1, Geology
- „ 2, Mineralogy.

GROUP VI.

- „ 1, Animal Physiology.
- „ 2, Zoology.

GROUP VII.

- „ 1, Vegetable Physiology and Economic Botany.
- „ 2, Systematic Botany.

GROUP VIII.

- „ 1, Mining.
- „ 2, Metallurgy.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers.
(See § xv., xviii., xix., xx., and xxi.)
2. Grants towards the purchase of apparatus, &c.
(See § xxiii.)
3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., xix., and xx.)

VIII. Examinations for certificates to Examinations for Teacher's Certificates. teach any of the before-mentioned sciences are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. Certificates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he is certificated.

IX. Suitable premises, with firing, lighting, &c., must be found and maintained School Premises. at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee. than five well known responsible persons

must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. See pages 15 to 18.

Examination
of Classes
under Cer-
tificated
Teachers.

XI. The Science and Art Department holds, through the agency of each Local Committee, in May of each year, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x, xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv., xviii., xix., and xx.) Application for it must be made (on Science Form No. 119. See page 19, which will be sent on application) to the Secretary of the Science and Art Department before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined.

All registered Students of Science Classes under certificated teachers (except Science certificated teachers) are eligible to receive Queen's prizes and Queen's medals under the conditions hereafter mentioned. (See § xv., xvi., and xvii.)

Examination
of other
Classes.

XII. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 15 to 18, Science Form, No. 88*a*.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not be insisted on at present.

XIV. Any persons whatever, whether taught by the certificated teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

These candidates, if artisans, are eligible to receive Queen's prizes and certificates of merit (see § xvi. and xviii.); if registered students in artisan classes, they are eligible to receive Queen's medals, Queen's prizes, and certificates of merit under the conditions mentioned in § xvi. and xvii.; and if middle class students to receive certificates of merit.

XV. The results of the May examination are classified under the following heads:—(1) first class, (2) second class, (3) third class, (4) honourable mention, (5) pass, and (6) failed. The names of the successful candidates, those under the first five heads, are published. The

Places of
Examination.

Examination
of other
Students.

Classification
of Results.

standard of attainment required may be raised from year to year. For the *Pass* it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as honourable mention, or as 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, except that a student who has once received a 1st, 2nd, or 3rd class Queen's prize cannot receive the same or a lower class prize in the same subject again. If such student should be again successful, his name will simply be recorded in the published list. (See the conditions to § xi, xii., and xiv.)

Queen's
Medals.

XVII. The Queen's medals are—one gold in each group, one silver, and two bronze in each subject for competition throughout the United Kingdom.

Only registered students of schools and classes under Local Committees (see § xi. and xii.) can obtain medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to
Teachers.

XVIII. Payments are made to the certificated teacher in those subjects in which he is certificated on the following scale:—1*l.* for every student of the industrial classes who *passes* in *each* subject; 2*l.* for every one who obtains an *honourable mention*; 3*l.*, 4*l.*, or 5*l.* for every one who obtains a 3rd, 2nd, or 1st class Queen's prize;

provided that such student has received 25 lessons at least from the certificated teacher in each subject since the last examination, each lesson being an attendance at a meeting of the school of at least three quarters of an hour duration on a separate evening.*

The 30 lessons need not necessarily be all given in one year, but may extend over a longer period. 5% is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and this, only, subject to the reductions entailed by § xix. and xx. That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received 3% for a 3rd class, he can only claim 2%. If the same pupil had previously taken a 2nd class the teacher could only claim 1% on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

XX. Payments are only made on the foregoing scale when they amount to not more than 60%. When on this scale they would amount to more than 60% the excess up to 40% is diminished by one quarter, the excess above 40% by one half. Thus payments which on the above scale would be 100% and 150% will be reduced to 90% and 115% respectively.†

XXI. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent

Form of Claim
for Payment.

* It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher, and is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

† Thus, 100, that is $60 + 40$, is reduced to $60 + 40 - \frac{1}{4}$ of 40 = $60 + 30 = 90$. 150, that is, $60 + 40 + 50$ is reduced to $60 + 30 + 25 = 115$.

on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 21.)

School
Register.

XXII. *A school register must be kept on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.*

Grants for
Apparatus.

XXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5*l.* to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 25.)

Travelling
Expenses of
Teachers.

XXIV. The travelling expenses (second-class railway fare, and 10*s.* per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in
an Elementary
School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXVI. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

XXVII. The certificated teacher of an elementary school receiving aid from the Educational Department, Whitehall, who has pupil-teachers to teach cannot receive payments on account of Science teaching, even if holding a Science certificate.

XXVIII. But certificated teachers of elementary schools receiving aid from the Educational Department who have not pupil-teachers to teach have their time out of school-hours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

APPENDIX.

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT
THE ROYAL SCHOOL OF MINES.

At the May 1865 examination three of the following Royal Exhibitions and Free Admissions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Eight Royal Exhibitions of the value of 50*l.* each per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination, viz.:—

To a 1st grade Queen's Prize, in any subject	-	9 marks.
To a 2nd " " "	-	7 " "
To a 3rd " " "	-	5 " "
To an honourable mention	-	3 " "
To a pass	-	1 " "

and in addition—

For a gold medal	-	13 " "
For a silver medal	-	7 " "
For a bronze medal	-	5 " "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions.

FREE ADMISSIONS.

2. Free admissions to the lectures at the School of Mines.

A free admission is granted to any person who takes a gold medal in the May examination.

There are, in addition, the following Scholarships attached to the School—

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S
SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 30*l.* each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 15*l.* each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 25*l.* to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations

of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS
AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.

- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
 - d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.
 - e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artisans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 40 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.
5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- [1. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
- 2. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
- 3. It is absolutely necessary that at least two such responsible persons should agree to act.
- 4. The Committee must consist of a Chairman, Secretary, and at least three other Members.
- 5. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
- 6. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
- 7. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—3*l.* for the duties connected with any Science school or class consisting of 5 or more pupils which is examined and 1*l.* in addition

for each further day's examination held. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.

8. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by _____

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed.

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	OCCUPATION.
_____ <i>Chairman.</i>		
_____ <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

B

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

Name of Town

Place, as Mechanics' Institution, &c., in which the Classes are held

Name of Street, No., &c.

Name of Teacher or Teachers

Their private addresses

Total No. of individual Students

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)

SCIENCE FORM, No. 11a.

South Kensington, March 1864.

APPLICATION FROM

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.		Navigation.
	Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology, Economics, & Systematic Botany.		Mining and Metallurgy.		
	Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		
	I.	II. III.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	
Number of students under instruction during the year - }																	
Number intending to present themselves for examination }																	
Number intending to present themselves for examination not belonging to the class - }																	

Total number of students * under instruction during the year.

Total number of students * intending to present themselves for examination

Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

AN ACCOUNT OF TRAVELLING AND PERSONAL EXPENSES DISBURSED AND
CHARGED BY

Thomas Jones,

From the *2nd January 1860*, to the *4th January 1860*.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £ is due to me for the services stated.

Thomas Jones.

[Name and title of officer to be specified.]

Teacher of Chemistry in———School of Manchester.

Date upon which the services were Performed.	In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.	TOTAL AMOUNT.
<i>1860.</i>	<i>To attend examination in Chemistry held at South Kensington on 3rd January 1860.</i>	
<i>2nd January.</i>	<i>Railway fare from Manchester to London (and Class) - 1 4 0</i>	
<i>3rd January.</i>	<i>Omnibus fare to and from Euston Square and South Kensington - 0 1 0</i>	
<i>4th January.</i>	<i>Railway fare from London to Manchester - 1 4 0</i>	
		<i>3 9 0</i>
	<i>8 days' personal allowance at 10s. - - - - -</i>	<i>1 0 0</i>
		<i>3 9 0</i>

NOTE.—Should the successful candidate live in London or near enough to get home at night, he is only to be allowed ss. per diem besides his travelling expenses.

Examined and approved,

Secretary.

Received this _____ day of _____ 18 _____, the sum of _____ pounds _____ shillings and _____ pence, in payment of the above amount.

£ _____

SCIENCE FORM No. 51.

South Kensington, July 1864.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from _____ Science Teacher in _____
School or Institution at _____ for payment.

On behalf of the Committee of Management of this School, We do hereby certify :—

- (1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .
- (2). That he has given the following Students at least 40 lessons during the year, or since the last examination at which payment was claimed on their account.
- (3). That the under-mentioned students are *artizans or operatives* * in the receipt of weekly wages, supporting themselves by their own manual labour ; or their children not earning their own livelihood.

_____ } Secretary.
Two mem-
bers of
Committee.

I hereby certify that the following particulars are correct.

_____ Teacher.

NAMES OF PASSED *ARTISAN OR OPERATIVE* STUDENTS.*

N.B.—These names should be arranged alphabetically. If the same student comes up and is claimed on in more than one subject, the name, &c. should be ditto ditto, and the last three columns filled up with the several successes, so that the whole of these and the whole amount claimed for a candidate may appear in one place.

Surname, Christian name in full.	Age last Birth-day.	Trade, or father's trade. (State which is given).	Position at the late Examination.			Highest Position in same Subject at any previous Examination.	Amount claimed.	
			Group.	Sub.	Class.		£	s.
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
&c.	&c.							

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _____ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.

- a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c.
 - b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so (such as shopkeepers who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c.
 - c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c. We certify :—
- (1). That he has given them forty (40) lessons at least during the year, or since the last examination at which payment was claimed on their account.
 - (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
 - (3). That the following particulars on which the Teacher grounds his application are correct.

Secretary.

Two mem-
bers of
Committee.

I hereby certify that the following particulars are correct.

Teacher.

NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES.

N.B.—These names should be arranged alphabetically. If the same student comes up and is claimed on in more than one subject, the name, &c. should be ditto ditto, and the last three colums filled up with the several successes, so that the whole of these and the whole amount claimed for a candidate may appear in one place.

Surname, Christian name in full.	Age last Birth-day.	Trade, or father's trade. (State which is given).	Position at the late Examination.			Highest Position in same subject at any previous Examination.	Amount claimed.	
			Group.	Sub.	Class.		£	s.
1. _____								
2. _____								
3. _____								
4. _____								
5. _____								
6. _____								
7. _____								
8. _____								
9. _____								
10. _____								
&c. &c.								

The Secretary,
Science and Art Department.

(The following particulars will be filled up at South Kensington).
Examined and found correct to the extent of _____

Approved _____ day of _____ 186
_____ day of _____ 186

CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS, &c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES (TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),* IN PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation; towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality;

* Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditional that is, the Department will aid them to the extent of 5*l.*

and moderate in price. My Lords have therefore laid down the following rules and conditions:—

“1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

“2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

“3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard.”

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

No. 1 application to be filled in by Requisitionist, with full particulars.

	Male	Female	
Having _____			(*) Pupils (Artizans or Operatives) of the Science Class.
(*) Erase the words that do not apply.			
and _____			(*) Scholars or Members of Poor School or Mechanics Institute.
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____
per _____ at _____
Dated this _____ day of _____ 186 .
Signature of Requisitionist.

2. Requisition sent to M _____ day of _____ 186 . Agent.

this	and authority given for the supply of Articles to the extent of			
of				
	Net Sum			

No. 2 to be filled in by the Department.

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186 .

Articles (Retail Price)	-	-	-	£			
Deduct as above,—							
Aid by Department	-	-	-				
				£			
Add, for packing	-	-	-				
Total to be paid by Requisitionist	-	-	-				

No. 3 to be filled in by agent on transmission of the invoice.

4. Amount £ _____ received from schools this _____ day of _____ 186 . Agent.

No. 4 and 5 to be filled in by agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 . Agent.

6. Examples as per invoice received, and * Requisition returned to Agent, this _____ day of _____ 186 . Requisitionist.

No. 6 to be filled in by Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee, and those marked with an asterisk must also be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

* 3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,* who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day fixed for the examination.

* 7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee. No candidate may on any account be admitted after 7.30 p.m.

* 8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

* 9. When the candidates are seated and the papers given out, the Committee will see that the candidates *commence* by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room,† except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed.‡ Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the

* When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

† Except in the drawing examination, when drawing instruments are allowed.

‡ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form. If necessary the last page or pages may be taken for this purpose, but they must not be torn off.

examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

* 13. The examination papers being given out no candidate must be allowed to return after having once left the room.† On a candidate leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures.	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

* Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply especially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFICATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

Any certificate obtained at the examination may be raised, by re-examination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum. or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

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|----------|------------------------------------|-----------------------------------|
| Group I. | - Geometrical Drawing, &c. | Prof. T. Bradley. |
| " | II. - Mechanical Physics | - Rev. B. M. Cowie, M.A. |
| " | III. - Experimental Physics | - Prof. Tyndall, F.R.S. |
| " | IV. - Chemistry | - Prof. Hofmann, F.R.S. |
| " | V. - Geology | - Prof. Ramsay, F.R.S. |
| " | Mineralogy, &c. | - Prof. W. W. Smyth, M.A., F.R.S. |
| " | VI. - Zoology | - Prof. Huxley, F.R.S. |
| " | VII. - Botany | - Edwin Lankester, M.D., F.R.S. |
| | Navigation and Nautical Astronomy. | J. Riddle, F.R.A.S. |
| | Physical Geography | - Dr. G. Kinkel, F.R.G.S. |

A Second Course has been delivered, of which the following have been published :—

- | | | | |
|-------------|---|-------------------------------|----------------|
| Lecture I. | - Vegetable Physiology and Economic Botany. | Edwin Lankester, M.D., F.R.S. | 3rd February. |
| Lecture II. | Mechanical Physics | Rev. B. M. Cowie, B.D. | 10th February. |
| Lecture IV. | Mining | W. W. Smyth, M.A., F.R.S. | 24th February. |

SYLLABUS.

GROUP I.

PRACTICAL PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL AND MACHINE DRAWING, AND BUILDING CONSTRUCTION.

This group consists of three subjects, viz.,—(first subject) Practical Plane, and Descriptive Geometry. (Second subject) Mechanical and Machine Drawing. (Third subject) Building Construction. And it is open to the candidate, to pass in either of the subjects alone, or in all, but a teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the “scale of chords” for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinate to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of “scales” plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* and the *vernier* subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.
6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 + b^2}$, &c.
7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term *projection*, and of the necessity for it, in order to express graphically, on a surface, *solids* of any kind; the distinction between *orthographic* and *perspective projections*; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

Why the projections, of any solid consisting of a combination of geometric forms, on two or three *co-ordinate planes* are necessary to show the form and dimensions of that solid.

Meaning of the terms *plan*, *elevation*, *profile*, *section*. The principle of the representation of *surfaces* by the projections of their generators, or of equi-distant horizontal sections termed *contours*. The direction and inclination of an indefinitely extended plane given by its contours, or by its *traces* on any two co-ordinate planes.

These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.

A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—

1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.

2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.
3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry. Text-Books for Practical Plane Geometry.—Bradley's *Geometrical Drawing*; Burchett's *Practical Geometry*; *Practical Geometry, Linear Perspective and Projection* (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's *Geometrical Drawing*; Hall's *Elements of Descriptive Geometry for Students in Engineering*.—Heather's *Descriptive Geometry*. Also the following French Works, which are

mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—*Elémens de Géométrie Descriptive*, par S. F. Lacroix ; *Traité de Géométrie Descriptive*, par Levebure de Fourcy ; *Nouveau Cours raisonné de Dessin Industriel*, par Armengaud, aîné, et Armengaud, jeune, et Amouroux ; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bonâ fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage ; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry ; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction ; the same description of attainments will be required.

GROUP II.

MECHANICAL PHYSICS.

This group is taken under two subjects.

Subject I.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject II.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in *actual practice*: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended.—Willis's *Mechanism*; Baker's *Elements of Mechanism*; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics*; Goodeve's *Elements of Mechanism*.

GROUP III.

EXPERIMENTAL PHYSICS.

This group is taken under two subjects.

Subject I.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch, of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject II.—Magnetism and Electricity.*Magnetism.*

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

GROUP IV.

CHEMISTRY, INORGANIC AND ORGANIC.

This group is taken under two subjects.

Subject I.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: *Oxygen*. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of carbonate of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese, *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. Nickel. Chromium. Zinc. Cadmium. Copper. Lead. Manufacture of white lead.
Bismuth. Mercury. Tin. Arsenic. Course of analysis in cases of poisoning.
Antimony. Silver. Gold, and platinum. Their principal compounds with the non-metallic elements.
 Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Watch glasses.
Metal filter stand.	Porcelain crucible.
Wash bottle containing distilled water.	Triangles.
Spirit lamp.	Test tube cleaner.
Black blowpipe.	Platinum wire and foil.
Charcoal for blowpipe experiments.	Funnels.
Iron spoon.	Cut filters.
Tongs.	Sulphuretted hydrogen apparatus.
Pestle and mortar.	Platinum crucible.
Porcelain dishes.	Herapath's blowpipe.
	Stirring rods.

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Sulphate of potassium.
Hydrochloric acid.	Sulphate of magnesium.
Nitric acid.	Chromate of potassium.
Hydrosulphuric acid.	Oxalic acid.
Potassa.	Tartaric acid.
Ammonia.	Acetic acid.
Chloride of ammonium.	Hydrofluosilicic acid.
Sulphide of ammonium.	Oxalate of ammonium.
Carbonate of ammonium.	Acetate of lead.
Phosphate of sodium.	Sesquichloride of iron.
Chloride of barium.	Ferrocyanide of potassium.
Chloride of calcium.	Chloride of platinum.
Lime water.	Nitrate of silver.
Sulphate of calcium.	

In the solid state.

Carbonate of sodium.	Lime.
Nitrate of potassium.	Sulphate of iron.
Cyanide of potassium.	Blue and red litmus paper.
Borax.	

Subject II.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol. Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines: their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books.—Graham's *Elements of Chemistry*, Miller's *System of Chemistry*, Fownes' *Manual of Chemistry*, Gregory's *Outlines of Chemistry*, Abel and Bloxam's *Handbook of Chemistry*, Galloway's *Qualitative Analysis*.

GROUP V.

GEOLOGY AND MINERALOGY.

This group is taken under two subjects.

Subject I.—Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.
3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.
4. Volcanoes and volcanic phenomena.
5. The theory of central heat.
6. Elevation and depression of land.
7. The ordinary mineral substances that enter into the composition of rocks.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.
2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-stones, limestones, and marbles.
3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.

4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.
 5. The new red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits, rock salt, and brine springs.
 6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.
 7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.
 8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.
 9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.
 10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
 11. Crag. Its subdivisions, chief fossils, phosphatic remains.
 12. Disturbance and denudation of strata.
 13. Unconformities, faults, and fractures.
 14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
 15. Water-bearing strata, and underground drainage. Artesian and other wells.
 16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.
 17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.
 18. The occurrence of stream tin, gold, &c., in superficial detritus.
 19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.
- Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*.

Subject II.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and

- specific gravity ; 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour ; 3rdly, as to their electric and magnetic properties.
- e. The chemical characters of minerals, and the most convenient modes of testing them ; 1st, by aid of the blowpipe ; 2ndly, by the moist way.
 - f. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.
 - g. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London, 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On *Crystallography*. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*," London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood on the *Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

GROUP VI.

ANIMAL PHYSIOLOGY AND ZOOLOGY.

This group is taken under two subjects.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog ; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Subject I.—Animal Physiology.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death:—1st, as a part of life; *e.g.* moulting, shedding of skin and teeth. 2nd, as opposed to life; *e.g.* sloughing and mortification.

General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the foetus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject II.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms, classes, and orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia, Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—*Hydra, Sertularia, Plumularia, Actinia, Corallum, Fungia, Oculina*.

iii. Starfishes, sea urchins, and *Holothuræ*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster, Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lambdus, Hirudo, Distoma, Tenia, Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—*Cancer, Homarus, Astacus, Oniscus, Daphnia, Cyclops, Lepas, Balanus, Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria, Scorpio, Scolopendra, Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha, Blatta, Libellula, Phryganea, Coccus, Aphis, Bombyx, Apis, Vespa, Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells"

(*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads. Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodylus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implantal mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hibernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*, *Cervus*, *Bos*, *Ovis*, *Felis*, *Phoca*, *Phocæna*, *Dasypus*, *Halmaturus*, *Ornithorhynchus*.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's *Animal Physiology*, Bohn, 1859; Dr. Kirke's *Manual*; Andrew Combe's *Physiology applied to Health and Education*. For Zoology.—Dallas's *Natural History of Animals*; Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Green's *Manual of the Protozoa*.

GROUP VII.

BOTANY.

This group is taken under two subjects.

Subject I.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corolla, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.
11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafoetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject II.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Alge*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myricid*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpacæ*, *Cannabinacæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*.
16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
18. *Labiataæ*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.

22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellatæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbelliferae*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Aethusa*, *Eranthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Cruciferae*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alliaria*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

GROUP VIII.

MINING AND METALLURGY.

This group is taken under two subjects.

Subject I.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for ; description of varieties in use ; lining of bore-holes.

5. Management and supervision ; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation ; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation ; practice of mines where simple natural ventilation is employed ; ventilation of large areas and of deep or complicated workings by guiding the natural current ; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy ; safety lamps in all their best modifications ; circumstances under which they should be employed ; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines ; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines ; construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding ; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them ; construction of the lifts ; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels ; mode of building them.

Tubbing of water from shafts ; conditions under which it may be done ; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance ; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts ; various methods in use ; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads ; protection against over-winding ; safety clutches, &c. in case of breakage of rope.

9. Opening of ground ; quarries and open work ; driving of levels, various dimensions and directions according to circumstances ; sinking of shafts, inclined or perpendicular ; advantages of either kind under certain conditions ; means of securing levels and shafts by timber or by walling ; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations ; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts ; prevention of accidents by proper fitting and dividing ; mode of placing ladders and sollars ; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps ; washing of coal ; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works :—

De la Beche's *Report on Cornwall and Devon*. Greenwell's *Treatise on Mine-Engineering*. Dunn on the *Winning and Working of Collieries*. Hedley on *Colliery Working and Ventilation*. Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines*. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject II.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hähner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

LIST OF SCIENCE SCHOOLS AND CLASSES.

May 1864.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruction in 1863-4.	Subjects taught and Number in each Class in 1863-4.
Aberdeen . . .	Mechanics Institution .	Dr. Beveridge, D. Mavor.	J. Sinclair .	Mechanics Institute	39	26 Theoretical Mechanics; 9 in Geology; 6 in Vegetable Physiology and Economic Botany.
Almondbury . . .	King James' School .	G. Jarman .	Lewis Jones .	Almondbury . . .	16	16 in Inorganic Chemistry.
Bacup . . .	Mechanics Institution .	H. P. Meaden	T. Newbigging	Bacup . . .	21	21 in Inorganic and 21 in Organic Chemistry.
Banbridge . . .	Literary Mutual Improvement Society.	B. Tate .	A. Black .	Banbridge . . .	23	23 Geology; 23 Animal Physiology.
Banbury . . .	British School .	J. H. Beale .	J. Cadbury .	Banbury . . .	99	50 Animal Physiology; 30 Zoology; 8 in Vegetable Physiology; 40 Systematic Botany.
Banbury . . .	Cherwell School Room .	D. Pidgeon .	" .	" .		
Banbury . . .	Britannia Schools .	D. Pidgeon .	" .	" .		
Banbury . . .	5 High Street .	T. Beasley .	Dr. S. Browne	Bandon . . .	—	12 Geology; 13 Animal Physiology and 13 in Zoology; 35 Vegetable Physiology; 35 Systematic Botany.
Bandon . . .	Museum . . .	B. Tate .	J. J. Murphy	Bandon Museum, College Sq., East, Belfast.		
Belfast . . .	Royal Academical Institution.	J. S. Holden .	W. Shepherd .	13, Donegall Place, Belfast.	34	31 Mathematics, 43 General Navigation, 38 Nautical Astronomy.
Belfast (Navigation)	" . . .	G. Doran .	B. Nesbitt .	Belfast . . .	113	47 Experimental Physics, Inorganic Chemistry.
Birmingham . . .	Birmingham and Midland Institute.	C. J. Woodward	W. Oliver .	Beaufort Road, Edgbaston	91	23 Acoustics, &c., 23 Inorganic Chemistry.
Bollington . . .	Large Sunday School .	G. J. Snelus .	J. Brooke, jun.	Hollin Hall . . .	23	89 Inorganic Chemistry; 34 in Vegetable Physiology and Economic Botany.
Bolton . . .	Holy Trinity Working Men's Institute.	J. Collins .	W. H. Traice .	124, Cheetham View, Pendleton.	89	20 Acoustics, &c.; 55 Inorganic, and 20 in Organic Chemistry. 26 Geology; 5 Zoology; 11 Vegetable Physiology; 8 Systematic Botany.
Bristol . . .	Trade School . . .	T. Coomber, H. Fulton, A. Lelpner.	J. Wilkison .	Bristol . . .	116	31 Experimental Physics; 63 Inorganic, 7 Organic Chemistry.
Burnley . . .	Mechanics Institute .	L. Clement .	J. Sutherland	Post Office, Burnley	71	

List of Science Schools and Classes—continued.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruction in 1893-4.	Subjects taught and No. in each Class in 1893-4.
Burnley	Church of England Literary Institution.	H. P. Meaden	E. W. Briggs	Burnley	23	23 in Inorganic Chemistry.
Bury	The Bury Athenæum	T. Ward	E. Bunting	15, Water Street, Bury.	34	34 in Inorganic Chemistry.
Cheltenham	Young Men's Christian Association.	W. L. Notcutt	H. J. Moore	Cheltenham	20	12 Geology, and 12 Animal Physiology.
Chester	Mechanics Institute	E. A. Davidson	Rev. James Harris.	Chester	35	20 in Geometrical Drawing; 15 Mechanical and Machine Drawing; 5 Building Construction; 1 Animal Physiology; 1 Zoology.
Chipping Campden	National School Room	E. H. Macmillan	Rev. J. Hamilton.	Chipping Campden, Gloucester.	17	17 in Inorganic Chemistry.
Christchurch	The Townhall, Church.	W. Judd	Henry Jenkins	Christchurch	17	50 in Inorganic Chemistry; 10 in Geology.
Corngraves	Night School Room	J. Jones	J. Stokes	Dudley	60	25 in Animal Physiology, and 1 in Vegetable Physiology and Economic Botany.
Corsock	" " " "	Miss M. Macornish.	J. Ferguson	Corsock by Dalbeattie.	25	18 Geometrical Drawing; 21 Mechanical Drawing; 2 Building Construction; 1 in Animal Physiology.
Crewe	Mechanics Institution	E. A. Davidson	T. Stubbs	Crewe	28	3 Magnetism, &c.; 3 Acoustics, &c.; 28 Inorganic, and 28 Organic Chemistry; 5 Geology; 5 Animal Physiology; 5 Zoology; 12 Vegetable Physiology; 12 Systematic Botany; 3 Mining; 28 Metallurgy.
Drogheda	Mechanics Institute	J. Dowling	P. J. Grey	Drogheda	40	4 Magnetism; 4 Acoustics; 23 Inorganic, 23 Organic Chemistry; 6 Geology; 6 Animal Physiology; 6 Zoology; 18 Vegetable Physiology; 18 Systematic Botany; 23 Metallurgy.
Dublin	Mechanics Institute	J. Dowling	M. McPadden	18, Anne Street, N.E., Dublin.	32	15 in Inorganic Chemistry; 9 in Geology, 55 Geometrical Drawing.
Dudley	Mechanics Institution	J. Jones	J. Stokes	Dudley	34	17 in Inorganic Chemistry.
Dundee	School of Art	J. Kennedy	D. Ewing	116, Seagate	55	
Elland	Mechanics Institute	J. G. Jarman	D. Brook	South Terrace	17	

Glasgow	Andersonian University	G.C. Foster, R.A. Dr. Buchanan, Dr. F. Penny, J. Mayer.	J. McCollan, Jr.	Glasgow.	
Glasgow (School of Mines.)	Carlton Place	-	R. S. Ounlike	Glasgow	139
Gloucester	Blue Coat School	W. Jeffery	C. Y. Crawley	Gloucester	55
Gunnislake	-	R. Pearce, C. Twite, G. Jarmain.	W. M. Phillips	Gunnislake	90
Hallfax	Working Men's College	H. P. Meaden	G. Gibbs	Haley Hill	18
Hawkingden	The Institute	-	J. Binns	Hawkingden	31
Helston	Mining School	R. Pearce,	R. E. Cunneen	Helston	13
Hereford	Proprietary School	R. Tate	R. M. Lingwood	Hereford	17
Holywood	The Sullivan's School	-	W. Shepherd	13, Donegal Place, Belmet.	67
Huddersfield	Literary and Scientific Society, Queen Street.	G. Jarmain	G. W. Rhodes	30, Ramsden Street	21
Hull (Navigation)	Nautical Schools, King- ston-upon-Hull.	Z. Scapling	E. S. Wilson	Hull	71
Hulme	Manchester Christ Church Institution, Hulme.	J. Hartley	B. Clayton	Hulme	10
Kidderminster	Mechanics Institute	M. W. Packer	J. E. Stone	Green Place, Kid- derminster.	14
Kinver	Science School	M. W. Packer	T. Bolton	Hyde House, near Sourbridge.	14
Leeds	Mechanics Institution	G. Ward	B. Blake	Mechanics Institu- tion.	40
Leith (Navigation)	-	J. Bohn	Rev. J. Thom- son.	4, Jamaica Street, N. Leith.	237
Liverpool	Free Library, William Brown Street.	N. Samuelson, Dr. Colling- wood, E. H. Birken- head,	E. B. Bright, J. Samuelson.	William Brown Street, Liverpool.	125
London: Bethnal Green	Birkbeck Schools	R. W. Pike	G. Eduntz	Birkbeck Schools, Bethnal Green.	31

16 Inorganic, 16 in Organic Chem-
istry; 97 Animal Physiology; 93 Zoo-
logy; 40 Vegetable Physiology; 40
Systematic Botany; 14 Mining and
70 Metallurgy.
55 Magnetism, &c.; 51 Inorganic Che-
mistry.
15 Inorganic Chemistry; 15 Mineralogy.
12 Magnetism, and 18 Inorganic Che-
mistry.
18 in Acoustics, &c.; 18 Magnetism, &c.,
21 Inorganic Chemistry; 18 Animal
Physiology.
13 Inorganic Chemistry, and 13 in
Mineralogy.
17 in Inorganic Chemistry.
67 in Geology, and 67 in Vegetable
Physiology and Economic Botany.
21 in Inorganic Chemistry.
71 in Mathematics, General Naviga-
tion, Nautical Astronomy, Physical
Geography and Steam.
10 in Inorganic Chemistry.
14 in Inorganic Chemistry.
14 in Inorganic, and 4 in Organic
Chemistry.
40 in Inorganic Chemistry.
63 in Steam; 144 in Mathematics; 186
General Navigation; 182 Nautical
Astronomy; 42 Physical Geography.
72 in Acoustics, &c.; 8 Magnetism,
&c.; 27 Inorganic Chemistry; 33
Geology and Mineralogy; 16 Animal
Physiology and Zoology; 16 Vego-
table Physiology, Economic, and
Systematic Botany.
42 in Magnetism; 49 in Animal Phy-
siology.

List of Science Schools and Classes—continued.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under instruction in 1893-4.	Subjects taught and No. in each Class in 1893-4.
Bethnal Green -	St. Matthew's National Schools, Church Row, Bethnal Green.	B. Simpson -	J. H. Halliday	53, Squarries Street	44	43 in Acoustics, &c. and in Geology.
St. Thomas, Charterhouse, Kingsland -	St. Thomas, Charterhouse, British School Room -	P. G. Corbin -	G. Phillipson	39, Horton Square, Shoreditch	30	30 Inorganic Chemistry.
Ipsington -	British School Room -	B. Bithell -	W. H. Hoskins	24, Norfolk Road, Dalston.	67	24 Animal Physiology; 45 in Geometrical Drawing; 5 in Theoretical Mechanics
Ipsington -	Cross Street, Ipsington, Day School.	A. Jones -	C. Whittard -	23, Dalston Terrace, N.E.	280	280 in Animal Physiology; 50 Zoology.
Ipsington -	Lower Ipsington Public School, Windsor Street, Lower Road.	J. Howard -	J. Ross -	418, Shaftesbury Road, New North Road.	90	50 Magnetism, &c., and Animal Physiology; 25 Inorganic Chemistry; 90 Zoology.
Shadwell (Navigation).	The Town Hall -	J. Scott -	T. A. Fieldwick	Salvors' Institution, Shadwell.	33	32 Mathematics; 33 General Navigation; 25 Nautical Astronomy; 10 Physical Geography.
Loughborough -	Christ Church School, and Mechanics Institution.	G. J. Shelus -	C. H. Capp -	Loughborough -	24	24 in Inorganic Chemistry.
Macclesfield -	The Modern Free School	J. Chadwick -	J. Brooker -	83, Mill Street, Macclesfield.	44	24 in Acoustics, &c.; 13 in Magnetism, &c.; 30 in Inorganic, and 13 in Organic Chemistry.
Manchester -	Mechanics Institution -	J. Angell -	A. Jarrett -	33, Mill Street, Macclesfield, Mechanics Institution.	30	30 in Inorganic Chemistry.
Manchester -	68, Corporation Street -	F. Hudson -	W. Noar -	Town Hall, Salford	369	170 Geometrical Drawing; 84 Mechanical Drawing; 48 Building Construction; 29 Theoretical Mechanics; 80 Acoustics, &c.; 110 Inorganic and 25 Organic Chemistry; 169 Animal Physiology; 30 Metallurgy.
Manchester -	Cathedral School, Todd Street.	J. Collins -	Rev. G. Huntington, M.A.	Cathedral Schools -	24	30 Inorganic and 35 Organic Chemistry; 30 in Vegetable Physiology; 35 Systematic Botany.
Marston -	The Mechanics Institution.	G. Jarmain -	J. Pinder -	Peel Street, Brougham Road.	31	2 Theoretic Mechanics; 2 Acoustics, &c., and Magnetism; 21 Inorganic Chemistry; 9 Animal Physiology; 13 Vegetable Physiology.
					15	15 in Inorganic Chemistry.

Middleboro'	-	Mechanics Institution	W. Crossley	W. Taylor	West Newlands, Middleboro'	13	13 in Inorganic and 5 in Organic Chemistry.
Middleton	-	National School	J. Collins	Rev. J. B. Walker	Middleton	13	13 in Acoustics, &c., and Magnetism, &c., and Inorganic Chemistry.
Nelson in Maresden	-	Mechanics Institution	L. Clement	J. Sutherland	Post Office, Burnley	19	19 in Inorganic and 3 in Organic Chemistry.
Netherton	-	Mechanics Institution	G. Jarmain	B. Bentley	South Croslund, near Huddersfield, 18, Morley Street, Newcastle.	24	24 in Inorganic Chemistry and 23 in Geology.
Newcastle-on-Tyne	-	Mechanics Institution	W. Johnston	A. Carse	-	48	48 in Inorganic Chemistry.
Newtown	-	National School	W. Gunn	R. Benbow	Park Street, Newton	9	9 in Animal Physiology.
Newtownards	-	National Model School	W. H. Greer	M. Harbison	Model School, New-	38	38 in Acoustics, Light, and Heat, and in Magnetism and Electricity.
Nottingham	-	Mechanics Institution	Dr. T. Wilson	R. Thurlow	North Church Street	17	17 in Inorganic Chemistry.
Oldcastle	-	-	A. Smyth, J. Besty.	R. O'Neill	Oldcastle, County Meath.	53	53 in Acoustics, &c., and in Inorganic Chemistry.
Oldham	-	Parish Church Schools	J. Mellor	Rev. D. M. Alexander.	Oldham	108	146 in Practical, Plane, and Descriptive Geometry; 92 in Mechanical and Machine Drawing; and 54 in Building Construction.
Oldham	-	Literary Institution	T. Butterworth	S. Ingham	Oldham	30	30 in Practical, Plane, and Descriptive Geometry.
Padtham	-	Trades Hall	L. Clement	J. Sutherland	Post Office, Burnley	16	16 in Inorganic and 9 in Organic Chemistry.
Painewick	-	Free School	M. Pullen	J. M. Skinner	New Street, Painewick.	25	25 in Practical, Plane, and Descriptive Geometry.
Queensbury	-	Queensbury School	J. Halliday	G. Turner	Queensbury	7	7 in Inorganic Chemistry.
Redditch	-	Mechanics Institution	H. P. Meaden	T. Thomas	Redditch	18	18 in Inorganic Chemistry.
Salford	-	Literary and Scientific Institution.	T. W. Shore	V. Milward	Redditch	38	38 in Animal Physiology.
Salford	-	Working Men's College	C. O'Neill and J. Plant.	W. Noar	Town Hall, Salford	66	23 Geometrical and 34 Mechanical Drawing; 24 Inorganic and Organic Chemistry; 11 Geology.
Slathwaite	-	Mechanics Institution	G. Jarmain	J. Pickles	Mechanics Institution.	30	20 in Inorganic Chemistry.
Slough	-	Mechanics Institution	J. Dorrell	J. Chapman	Upton Grove, Slough	53	53 in Geometrical and Mechanical Drawing.
St. Day	-	The Institution	R. Pearce	F. H. Hawke, jun.	Tolkulla, Scorrier, Cornwall.	13	12 Geometrical; 23 Mechanical Drawing; 8 Building Construction.
Stockport	-	Mechanics Institution	W. Hudson	S. Robinson	60, Church Gate	29	45 in Inorganic, 8 in Organic Chemistry; 23 in Geology; and 23 Animal Physiology.
Stroud	-	Lecture Room, King Street.	W. Vick and M. M. Pullen.	S. J. Dudbridge	Bowbridge House, Stroud.	75	8 in Theoretical Mechanics; 11 in Acoustics, Light, and Heat.
Tintwistle	-	National School	W. Cooper	P. Taylor	Tintwistle	19	

List of Science Schools and Classes.—continued.

Town.	Where held.	Teacher.	Secretary.	Secretary's Address.	Total No. under Instruction in 1883-4.	Subjects taught and No. in each Class in 1883-4.
Upton St. Leonards	School Room - - -	U. J. Davies -	Rev. John Betts	Parsonage, Upton St. Leonards.	31	31 Vegetable Physiology and Economic Botany.
Walsall - - -	Grammar School, Lichfield Street - - -	- Jones -	Rev. A. C. Irvine.	Grammar School -	50	50 in Inorganic Chemistry.
Waterford - - -	Model School - - -	J. Dowling -	F. Hardley -	Waterford -	19	19 in Geology.
Wednesbury - - -	Mechanics Institution -	J. Jones -	C. Britten -	Market Place, Wednesbury -	10	10 in Inorganic Chemistry.
Wigan - - -	Mining and Mechanical School -	E. H. Birkenhead.	M. W. Peace -	Greenhill, Wigan -	115	76 Geometrical and Mechanical Drawing; 5 in Theoretical Mechanics; 2 Applied Mechanics, Acoustics, &c.; 2 Inorganic and 1 Organic Chemistry; 23 Geology; and 20 Mining.
Wolverhampton -	Working Men's College and Christian Institute.	J. Jones and J. Hough.	J. N. Langley, M.A.	Mowbray House -	14	14 Inorganic Chemistry.
Wolverton - - -	Mechanics Institution -	Rev. F. W. Harnett, W. Stone.	J. Orton -	Wolverton - -	38	19 Geometrical, 19 Mechanical Drawing; 18 Magnetism, &c.; 26 Inorganic Chemistry.
Woolwich - - -	Mechanics Institution -	T. Jones and W. T. Bowden.	E. McGrath -	Royal Gun Factory, Office -	54	46 in Geometrical, 45 in Mechanical Drawing; 15 in Magnetism, &c.
Yarmouth (Navigation).	- - - - -	- - - - -	M. Butcher -	Navigation School -	143	81 Mathematics; 71 Nautical Astronomy; 71 General Navigation; 11 Physical Geography.

TABLE OF HONORARY DIPLOMAS granted without EXAMINATION.

Name.	Address.	Group I. Geometrical Drawing, &c.			Group II. Mechanical Physica.		Group III. Experi- mental Physica.		Group IV. Chemistry.		Group V. Geology and Miner- alogy.		Group VI. Animal Physi- ology and Zoology.		Group VII. Vegetable Physiology and Econo- mic Botany.		Group VIII. Mining and Metallurgy.	
		Subject.			Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.	
		I.	II.	III.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Brazier, Professor	Aberdeen	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..
Collingwood, Dr.	Liverpool	..	..	..	..	..	..	..	..	..	..	1st	1st	1st	..	..	..	..
Carter, E. B.	Stroud, Gloucester- shire	..	..	..	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..
Pepper, John H.	Polytechnic Institute, Regent St., London.	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..

TABLE showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination of November 1864.

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1859 came into operation.

Name.	Address.	Group I. Geometrical Drawing, &c.			Group II. Mechanical Physics.			Group III. Experimental Physics.			Group IV. Chemistry.			Group V. Geology and Mineralogy.			Group VI. Animal Physiology and Zoology.			Group VII. Vegetable Physiology and Economic Botany.			Group VIII. Mining and Metallurgy.		
		Subject.			Subject.			Subject.			Subject.			Subject.			Subject.			Subject.			Subject.		
		I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.	I.	II.	III.
Abbott, Joseph	Collegiate Institution, Liverpool	..	..	..	..	..	..	1st	..	..	1st	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..
Aldread, Edwin	Training College, Battersea	..	..	..	..	..	..	1st	..	..	1st	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..
Allen, Alfred H.	14, Fernley Place, Glossop Road, Sheffield	..	..	..	..	..	..	1st	..	..	1st	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..
Allott, James	National School, Ruabon, North Wales	..	..	..	..	..	..	1st	..	..	1st	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..
Allen, William	Grammar School, Moulton, near Spalding	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Angell, John	Mechanics' Institute, Manchester	..	..	..	..	..	..	2nd	..	..	1st	..	..	..	..	..	1st	..	..	..	..	..	..	..	..
Arthey, William	Wilde's Endowed School, Lowestoft	..	..	..	..	..	..	3rd	..	..	2nd	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..
Atkins, Edward	St. Martin's School, Leicester	..	..	..	..	..	..	3rd	..	..	2nd	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Atkins, George	Laxton Street School, Leicester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bailey, Edward J.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ballock, John H.	14, Claremont Place, North Brixton, London	..	..	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Bannister, Richard	7, Coulson Street, Chelsea	..	..	..	..	..	..	..	..	..	1st	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Barret, E.	31, Gloucester Street, Regent's Park	..	..	..	..	..	..	2nd	..	..	1st	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Bartley, George C. T.	Baling	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beale, John H.	Science School, Banbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beatty, John	Endowed School, Oldcastle	..	..	..	..	..	..	3rd	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beesley, Thomas	5, High Street, Banbury	..	..	..	..	..	..	2nd	..	..	1st	1st	..	..	..	..	..	..	..	..	..	..	..	..	..
Bentley, Buzi	Kirkheaton	..	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Berriman, John	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beveridge, Robert	2, Upperkirkgate, Aberdeen	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Birkenhead, Edward H.	Mining School, Wigan	..	..	..	..	..	..	1st	..	..	2nd	2nd	..	..	..	..	1st	..	..	..	..	..	1st	..	..
Bithell, Richard	Orphans' Home, Halifax	..	..	..	..	..	..	2nd	..	..	1st	..	..	..	..	..	2nd	..	..	..	..	..	..	..	..

[illegible]

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.	
		Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology and Economic Botany.		Mining and Metallurgy.	
		I.	II. III.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I.	II.	Subject.	I. II.
Stevenson, James	Clark Street, Kilmarnock	2nd	..	..	2nd	..	..	..	..	..	..	..	..	..	..	..	..
Stirrup, Thomas	National School, Stockport, Cheshire	..	..	..	2nd	..	..	..	..	..	..	..	..	..	..	..	..
Stockton, William	4, Manor Terrace, East India Road, E.	..	..	..	2nd	3rd	..	2nd	..	..	..	..	..	..	..	..	..
Stone, William	Railiff Street, Wolverton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
*Strachan, Richard	11, Offord Road, Barnsbury, N.	..	..	..	3rd	2nd	..	3rd	..	..	..	..	..	..	..	..	..
Stroud, Robert	St. Mark's College, Chelsea	..	..	..	3rd	2nd	..	3rd	..	..	..	..	..	..	..	..	..
Swaine, James	Bridge Street, Frome, Somerset	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
*Tate, Ralph	Geological Society, Somerset House	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Taylor, Charles	Geological Society, Somerset House	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Taylor, Samuel	5, Havelock Terrace, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Taylor, William	Darfield School, Barnsley	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thackrah, Samuel	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Thomas, James D.	8, Colleton Buildings, Exeter	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tindall, George	Grove Street, Huddersfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tomkins, Samuel	Frampton Cotterill, Bristol	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tribe, Alfred	12, Westbourne Grove, North	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Trower, Richard	48, Over Street, Brighton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Turner, George	National School, Queenshead, Halifax	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Turner, Samuel O.	4, Marlboro' Terrace, Victoria Road, W.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Twite, Charles	Miners' Association, Truro	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Watt, William	National School, Cairncross, Stroud	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wickens, Thomas	British School, Torquay	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wilde, John	Darley Street School, Leeds	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wicketford, Frank D.	12, Ann's Terrace, Waltham Green	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ward, Thomas	Wesleyan S., Bridge Street, Bolton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

L O N D O N :
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODS,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[7253.—250.—9/64.]

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised in August 1865.)

12th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1865.

Price Sixpence.

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SCIENCE AND ART DEPARTMENT. COMMITTEE OF COUNCIL ON EDUCATION.

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Vice-President of the Committee of Council on Education, The Right Hon.
H. A. BRUCE, M.P.

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Instructor in Engineering Drawing.—John Maxton.

* The letters S and A refer to the Science and Art Certificates taken.

**SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.**

*[Important Alterations made since the last edition of the Directory are
printed in Italics.]*

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, or who do not possess an income of 100*l.* a year. (See § xiii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes, and Teachers, are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given:—

Subject 1, Practical Plane and Descriptive Geometry.

„ 2, Mechanical and Machine Drawing.

„ 3, Building Construction or Naval Architecture.

„ 4, *Elementary Mathematics.*

„ 5, *Higher Mathematics.*

„ 6, Theoretical Mechanics.

„ 7, Applied Mechanics.

„ 8, Acoustics, Light, and Heat.

„ 9, Magnetism and Electricity.

„ 10, Inorganic Chemistry.

„ 11, Organic Chemistry.

„ 12, Geology.

„ 13, Mineralogy.

„ 14, Animal Physiology.

„ 15, Zoology.

„ 16, Vegetable Physiology and Economic Botany.

„ 17, Systematic Botany.

„ 18, Mining.

„ 19, Metallurgy.

„ 20, *Navigation.*

„ 21, *Nautical Astronomy.*

„ 22, *Steam.*

„ 23, *Physical Geography.*

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers.
(See § xv., xviii., xix., xx., and xxi.)

2. Grants towards the purchase of apparatus, &c.
(See § xxiii.)
3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., xix., and xx.)

VIII. Examinations for certificates to Examinations for Teacher's Certificates. teach any of the before-mentioned sciences are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin and Edinburgh if five candidates register themselves for examination in Ireland and in Scotland. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he wishes to be examined. Certificates of three grades are given in each group and each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.*

IX. Suitable premises, with firing, light- School Premises. ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less Local Committee. than five well known responsible persons must be formed in connexion with every Science

* Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Class, who will carry out the instructions contained in Appendix. (See pages 14 and 16 to 20.)

Examination
of Classes
under Cer-
tified
Teachers.

XI. The Science and Art Department holds, through the agency of each Local Committee, in May of each year, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv., xviii., xix., and xx.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 20), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men three times a year in all seaports where the Local Committees are formed and are willing to undertake them. These examinations take place in the beginnings of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination
of other
Classes.

XII. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers; provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, pages 16 to 19, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not be insisted on at present.

XIV. Any persons whatever, whether taught by the certificated teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the general examination committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The results of the May examination and of the quarterly examination of seamen are classified under the following heads:—
 (1) first class, (2) second class, (3) third class, (4) fourth class, (5) pass, and (6) failed. The names of the successful candidates, those under the first five heads, are published. The standard of attainment required may be raised from year to year. For the *Pass* it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, *see a. and b.* (1) Students in Science Classes under Certificated Teachers ; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) *bonâ fide* artisans.

Other candidates, if successful, receive instead Certificates of merit recording their success.

The following are exceptions to the above rule.

a. Science Certificated Teachers ; and

b. Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be recorded in the published lists.

Queen's
Medals.

XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. *They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner.*

Only registered students of schools and classes under Local Committees (see § xi. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

Payments to
Teachers.

XVIII. Payments are made to the certificated teacher in those subjects in which he is certificated on the following scale:—17.

for every student of the industrial classes who passes in each subject; 2% for every one who obtains a 4th class; 3%, 4%, or 5% for every one who obtains 3rd, 2nd, or 1st class; provided that such student has received 25* lessons at least from the certificated teacher in each subject since the last examination, each lesson being an attendance, at a meeting of the school, of at least three quarters of an hour duration on a separate evening.

The 25 lessons need not necessarily be all given in one year, but may extend over a longer period. 5% is the maximum that can ever be claimed on account of the instruction of any one pupil in a subject, and this, only, subject to the reductions entailed by § xix. and xx. That is to say, for a pupil taking a 1st class for whom at a previous examination the teacher received the payment for a 3rd class, he can only claim 2%. If the same pupil had previously taken a 2nd class the teacher could only claim 1% on his account, and so on.

XIX. If a student be successful at the examination in more than one subject, the teacher can only claim half of the above payments in respect of such further subject in which he is successful.

XX. Payments are only made on the foregoing scale when they amount to not more than 60%. When on this scale they would amount to more than 60% the excess up to 40% is diminished by one quarter, the excess above 40% by one half. Thus payments which on the above scale would be 100% and 150% will be reduced to 90% and 115% respectively.†

* It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher, and is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

† Thus, 100, that is $60 + 40$, is reduced to $60 + 40 - \frac{1}{4}$ of 40 = $60 + 30 = 90$. 150, that is, $60 + 40 + 50$, is reduced to $60 + 30 + 25 = 115$.

Form of Claim
for Payment.

XXI. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 22.)

School
Register.

XXII. A school register must be kept on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for
Apparatus.

XXIII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5% to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 27.)

Travelling
Expenses of
Teachers.

XXIV. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in
an Elementary
School.

XXV. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction in Science that may be given during the three

attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXVI. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

Use of
Elementary
School
Premises.

XXVII. The certificated teachers of elementary schools receiving aid from the Education Department, Whitehall, who have pupil-teachers to teach, cannot receive payments on account of Science teaching, even if holding a Science certificate.

Masters with
Pupil-teachers.

XXVIII. But certificated teachers of elementary schools receiving aid from the Education Department who have not pupil-teachers to teach have their time out of school-hours at their own disposal, so far as official regulations are concerned, and may if further certificated in Science give scientific instruction under the Science and Art Department.

Masters without
Pupil-teachers.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.	
Before 30th November.	Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.
Constantly - - -	To visit the School and see that the Register is kept from day to day, and that everything is regular.
Before 1st January	To carefully fill in and send to the Department, Form No. 120.
Before 31st March	To send Form No. 119 applying for examination in May.
Before 24th April -	To see that Form No. 91 is hung up in the School-room.
On the 27th April	If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate <i>at once</i> to the Department.
During the May examinations.	The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent <i>at once</i> to the Department.
On the evening of examination.	The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.
After the May examinations.	On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.
	To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.
	To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS, SCHOLARSHIPS, AND PRIZES, AT THE ROYAL SCHOOL OF MINES.

At the May 1866 examination two of the following Royal Exhibitions to the Royal School of Mines will be open for competition independent of the prizes, &c. offered by the Science and Art Department.

ROYAL EXHIBITIONS.

1. Eight Royal Exhibitions of the value of 50*l.* each per annum entitling the holders to free admissions to all the lectures, and the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures and passes the examinations required for the associateship of the School.

All persons over 21 years of age, excepting artizans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination, viz.:—

To a 1st grade Queen's Prize, in any subject	-	-	9 marks
To a 2nd " " " "	-	-	7 "
To a 3rd " " " "	-	-	5 "
To an honourable mention	-	-	3 "
To a pass	-	-	1 "

and in addition—

For a gold medal	-	-	10 "
For a silver medal	-	-	7 "
For a bronze medal	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the School of Mines.

A free admission is granted to any person who takes a gold medal in the May examination.

There are, in addition, the following Scholarships attached to the School—

HIS ROYAL HIGHNESS THE DUKE OF CORNWALL'S SCHOLARSHIPS.

His Royal Highness the Prince of Wales, as Duke of Cornwall, has granted two scholarships of 30*l.* each. One becomes vacant every year, and will be competed for by those students only who have passed the examinations of the first two years of the curriculum required for associates. It is held for two years by the successful competitor.

ROYAL SCHOLARSHIPS.

Two scholarships of 15*l.* each are given to the students who shall stand highest on the list of those who have passed their examinations for the first year—and a scholarship of 25*l.* to that pupil, not being the Duke of Cornwall's scholar, who passes the best examinations after the end of the second year. These scholarships will be granted to those students only who have obtained first-class places in the examinations of their year, or in those of at least two of the Professors in the case of such students as take the two first years in one.

For further particulars see prospectus of the "Royal School of Mines," to be had on application at the Museum in Jermyn Street.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.

- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.

5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM of APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- [1. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
2. It is very desirable that as many persons as possible in recognised positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
3. It is absolutely necessary that at least two such responsible persons should agree to act.
4. The Committee must consist of a Chairman, Secretary, and at least three other Members.
5. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
6. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
7. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1*l.* annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1*l.* in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
8. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by _____

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed.

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS,	Occupation, specially stating how fulfilling the conditions of "K." and "I." above.

<i>Chairman.</i>		

<i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to resign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

**LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.**

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS,

To be made on its establishment, and annually (before the 1st January) of its continuation.

Name of Town _____

Place, as Mechanics' Institution, &c., in which the Classes are held _____

Name of Street, No., &c. _____

Name of Teacher or Teachers _____

Their private addresses _____

Total No. of individual Students _____

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for *new* members to *sign* the form undertaking to perform the various duties.)

SCIENCE FORM, No. 119.
SCIENCE SCHOOL FOR EXAMINATION IN MAY.

APPLICATION FROM

To be sent to the Secretary of the Science and Art Department before the end of March.

	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Group VII.		Group VIII.		Navigation.	
	Geometrical Drawing, &c.		Mechanical Physics.		Experimental Physics.		Chemistry.		Geology and Mineralogy.		Animal Physiology and Zoology.		Vegetable Physiology, Economic & Systematic Botany.		Mining and Metallurgy.			
	Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.		Subject.	
	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
Number of students under instruction during the year - }																		
Number intending to present themselves for examination }																		
Number intending to present themselves for examination not belonging to the class - }																		

Total number of students * under instruction during the year _____

Total number of students * intending to present themselves for examination _____

Name and address of the person to whom the examination papers are to be sent. _____

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

Application from _____ Science Teacher in _____
School or Institution at _____ for payment.

(1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .

(2). That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.

21. (3). That the under-mentioned students are *artizans or operatives* * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Two mem-
bers of
Committee.

I hereby certify that the following particulars are correct.

Teacher.

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deductions.

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 8, when they will be considered on their merits.

On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _____ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.

- a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c.
- b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so (such as shopkeepers who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c.
- c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c.

We certify to the best of our belief—

- (1). That he has given them (25) lessons at least during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
- (3). That the following particulars on which the Teacher grounds his application are correct.

Secretary.

Two mem-
bers of
Committee.

I hereby certify that the following particulars are correct.

Teacher.

NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES.

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success with the proper deductions.

Under the names of students in category "c" a line must be drawn:

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination. Subject. | Grade.	Highest Position in same subject at any previous Examination.	Payment claimed.
&c.						

**The Secretary,
Science and Art Department.**

(The following particulars will be filled up at South Kensington.)

Examined and found correct to the extent of

day of 186

Approved _____ day of _____ 186

[SPECIMEN.]

Science Form, No. 51.
South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from *John Smith*, Science Teacher in the *Science School*
or Institution at *Midhurst* for payment.

On behalf of the Committee of Management of this School, We do
hereby certify:—

- (1.) That *Mr. J. Smith* has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;
- (2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;
- (3.) That the undermentioned students are *artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.*

Wm. Brown, Secretary.

John Jones, { Two mem-
James Roninson, { bers of
Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Position in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade.		
<i>Adams,</i>	<i>James,</i>	22	<i>Carpenter,</i>	<i>X.</i>	<i>1st</i>	—	£ s.
"	"	"	"	<i>XI.</i>	<i>2nd</i>	<i>4th</i>	5 0
"	"	"	"	<i>XIV.</i>	<i>Pass</i>	—	1 0
<i>Barber,</i>	<i>John Wm. Henry.</i>	14	<i>Butcher (J)</i>	<i>X.</i>	<i>1st</i>	<i>2nd</i>	0 10
"	"	"	"	"	"	"	0 10
<i>Smith,</i>	<i>William,</i>	12	<i>Baker (J)</i>	<i>XI.</i>	<i>4th</i>	—	2 0
"	"	"	"	<i>I.</i>	<i>1st</i>	—	5 0

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 8, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _____ Secretary of the Local
Committee for the Science School or Class at _____
for payment of allowance for duties connected with the School, and for
superintending the examination.

Sir,

*Being entitled to payment according to the regulations of the
Science "Directory,"* for duties connected with the Science Class at _____
and for superintending the arrangements
for carrying out the examinations on _____ the following days
in May 186 , I request that the sum of £ _____ may
be paid to me, being the authorized fee.*

Dates of Examination.	Dates of Examination.	Dates of Examination.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

I am, Sir,

Your obedient Servant,

The Secretary,

Science and Art Department.

**CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS,
&c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES
(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),† IN
PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.**

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

* £1 annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5*l.*

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860,

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

"1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

"2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

"3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

1. REQUISITION for Aid in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

No. 1 application to be filled in by Requisitionist, with full particulars.

	Male	Female	
Having (*) Erase the words that do not apply.			(*) Pupils (Artizans or Operatives) of the Science Class.
and			(*) Scholars or Members of Poor School or Mechanics Institute.
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____
per _____ at _____
Dated this _____ day of _____ 186 .
Signature of Requisitionist.

2. Requisition sent to M _____ Agent.
this _____ day of _____ 186
and authority given for the supply of Articles to the extent _____
of _____
Net Sum

No. 2 to be filled in by the Department.

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186 .
Articles (Retail Price) £ _____
Deduct as above,—
Aid by Department £ _____
Add, for packing £ _____
Total to be paid by Requisitionist

No. 3 to be filled in by agent on transmission of the invoice.

4. Amount £ _____ received from schools this _____ day of _____ 186 .
Agent.

No. 4 and 5 to be filled in by agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 .
Agent.

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 .
Requisitionist.

No. 6 to be filled in by Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

* 3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day before that fixed for the examination.

* 7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

* 8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

* 9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room,‡ except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. § If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

† When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except in the drawing examination, when drawing instruments are allowed.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, *i.e.*, pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing must be torn off the form.

class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination begins it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

* 13. The examination papers being given out no candidate must be allowed to return after having once left the room.† On a candidate leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures. -	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

* Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFICATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

Any certificate obtained at the examination may be raised, by re-examination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

- Group I. - Geometrical Drawing, &c. Prof. T. Bradley.
 " II. - Mechanical Physics - Rev. B. M. Cowie, M.A.
 " III. - Experimental Physics - Prof. Tyndall, F.R.S.
 " IV. - Chemistry - Prof. Hofmann, F.R.S.
 " V. - Geology - Prof. Ramsay, F.R.S.
 Mineralogy, &c. - Prof. W. W. Smyth, M.A., F.R.S.
 " VI. - Zoology - Prof. Huxley, F.R.S.
 " VII. Botany - Edwin Lankester, M.D., F.R.S.
 Navigation and Nautical Astronomy. J. Riddle, F.R.A.S.
 Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

- Lecture I. - Vegetable Physiology and Economic Botany. Edwin Lankester, M.D., 3rd February. F.R.S.
 Lecture II. Mechanical Physics. Rev. B. M. Cowie, B.D. 10th February.
 Lecture IV. Mining - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the “scale of chords” for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of “scales” plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* and the *vernier* subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring a drawing*. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.

6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 + b^2}$, &c.

7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term *projection*, and of the necessity for it, in order to express graphically, on a surface, *solids* of any kind; the distinction between *orthographic* and *perspective projections*; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

Why the projections, of any solid consisting of a combination of geometric forms, on two or three *co-ordinate planes* are necessary to show the form and dimensions of that solid.

Meaning of the terms *plan*, *elevation*, *profile*, *section*. The principle of the representation of *surfaces* by the projections of their generators; or of equi-distant horizontal sections termed *contours*. The direction and inclination of an indefinitely extended plane given by its contours, or by its *traces* on any two co-ordinate planes.

These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.

A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—

1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed *Stereotomy*, and better and more significantly in French, "*Coupe de pierres*."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "*Geometry, Plane, Solid, and Spherical*" of the *Library of Useful Knowledge*, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry.

Text-Books for Practical Plane Geometry.—Bradley's *Geometrical Drawing*; Burchett's *Practical Geometry*; *Practical Geometry, Linear Perspective and Projection* (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's *Geometrical Drawing*; Hall's *Elements of Descriptive Geometry for Students in Engineering*.—Heather's *Descriptive Geometry*. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—*Elémens de Géométrie Descriptive*, par S. F. Lacroix; *Traité de Géométrie Descriptive*, par Levebure de Fourcy;

Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bonâ fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. *Arithmetic generally.*
2. *Geometry.*—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.
3. *Algebra.*—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple

equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions. Permutations, and Combinations. Binomial theorem for a positive integral index.

4. *Plane Trigonometry*.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and *vice versé*. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of $90^\circ, 45^\circ, 60^\circ, 30^\circ, 180^\circ, 120^\circ, 150^\circ$, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulae for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, $2A$, $3A$, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in terms of $\frac{A+B}{2}$ and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulae for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to *pass*, a competent knowledge of the following alone will be required:—

- (1.) Geometry. The first book of Euclid.
- (2.) Algebra, to simple equations and problems (inclusive).
- (3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain an honourable mention:—

- (1.) Geometry. The first three books of Euclid.
- (2.) Algebra, to quadratic equations.
- (3.) Plane trigonometry as far as solution of triangles, inclusive.
- (4.) ~~Spherical trigonometry, as far as solution of spherical triangles,~~

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

1. *Algebra*.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.
2. *Plane Trigonometry*.—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.
- Spherical Trigonometry*.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations*. When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates ; locks ; water-wheels ; turbines ; water-pressure engines ; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended,—Willis's *Mechanism* ; Baker's *Elements of Mechanism* ; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics* ; Goodeve's *Elements of Mechanism*.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated ; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds ; of pitch ; of harmony and discord ; to commit to memory the rates of vibration of the several notes of the gamut ; to be able to make sonorous vibrations visible by means of glass plates and membranes ; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light ; to be able to state the laws of both ; to explain what is meant by total reflection ; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it ; why a stick appears bent when dipped obliquely into water ; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex ; to describe the characters of their images, whether erect or inverted ; magnified or reduced ; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: *Oxygen*. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of carbonate of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese. *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. *Nickel*. *Chromium*. *Zinc*. *Cadmium*. *Copper*. *Lead*. Manufacture of white lead.

Bismuth. *Mercury*. *Tin*. *Arsenic*. Course of analysis in cases of poisoning.

Antimony. *Silver*. *Gold*, and *platinum*. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Iron spoon.	Platinum wire and foil.
Metal filter stand.	Tongs.	Funnels.
Wash bottle containing distilled water.	Pestle and mortar.	Cut filters.
Spirit lamp.	Porcelain dishes.	Sulphuretted hydrogen apparatus.
Black blowpipe.	Watch glasses.	Platinum crucible.
Charcoal for blowpipe experiments.	Porcelain crucible.	Hera path's blowpipe.
	Triangles.	Stirring rods.
	Test tube cleaner.	

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Phosphate of sodium.	Acetic acid.
Hydrochloric acid.	Chloride of barium.	Hydrofluosilicic acid.
Nitric acid.	Chloride of calcium.	Oxalate of ammonium.
Hydrosulphuric acid.	Lime water.	Acetate of lead.
Potassa.	Sulphate of calcium.	Sesquichloride of iron.
Ammonia.	Sulphate of potassium.	Ferrocyanide of potassium.
Chloride of ammonium.	Sulphate of magnesium.	Chloride of platinum.
Sulphide of ammonium.	Chromate of potassium.	Nitrate of silver.
Carbonate of ammonium.	Oxalic acid.	
	Tartaric acid.	

In the solid state.

Carbonate of sodium.	Borax.	Blue and red litmus paper.
Nitrate of potassium.	Lime.	
Cyanide of potassium.	Sulphate of iron.	

Subject XI.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines : their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books. — Graham's *Elements of Chemistry*, Miller's *System of Chemistry*, Fownes' *Manual of Chemistry*, Gregory's *Outlines of Chemistry*, Abel and Bloxam's *Handbook of Chemistry*, Galloway's *Qualitative Analysis*.

Subject XII—Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.
3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.
4. Volcanoes and volcanic phenomena.
5. The theory of central heat.
6. Elevation and depression of land.
7. The ordinary mineral substances that enter into the composition of rocks.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.
2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-stones, limestones, and marbles.
3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.
4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.
5. The new red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits, rock salt, and brine springs.
6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.
7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.
8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.
9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.
10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
11. Crag. Its subdivisions, chief fossils, phosphatic remains.
12. Disturbance and denudation of strata.
13. Unconformities, faults, and fractures.
14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
15. Water-bearing strata, and underground drainage. Artesian and other wells.
16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.
17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.
 19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*.

Subject XIII.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity; 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.
- E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.
- G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London, 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied

more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood *on the Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death:—1st, as a part of life; *e.g.* moulting, shedding of skin and teeth. 2nd, as opposed to life; *e.g.* sloughing and mortification.

General death:—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes:—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the foetus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms, classes, and orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia, Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—*Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina*.

iii. Starfishes, sea urchins, and *Holothuræ*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster, Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lumbricus, Hirudo, Distoma, Tania, Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

metamorphosis. The water flea as exemplifying a sexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Libellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells" (*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads. Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodylus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implantal mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*,

Cervus, Bos, Ovis, Felis, Phoca, Phocæna, Dasypus, Humaaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's *Animal Physiology*, Bohn, 1859; Dr. Kirke's *Manual*; Andrew Combe's *Physiology applied to Health and Education*. For Zoology.—Dallas's *Natural History of Animals*; Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Green's *Manual of the Protozoa*.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.
11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Algæ*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpaceæ*, *Cannabineæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*.
16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
18. *Labiataæ*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.

22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellatæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbellifereæ*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Bryngium*, *Apium*, *Sium*, *Æthusa*, *Oenanthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Cruciferaæ*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alliaria*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for; description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different

classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, trammimg, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's Report on Cornwall and Devon. *Greenwell's Treatise on Mine-Engineering.* *Dunn on the Winning and Working of Collieries.* *Hedley on Colliery Working and Ventilation.* Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines.* Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, con-

ductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a com-

bination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. *Elementary Principles*.—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale. Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

NOTE.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples.

For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon *below* the pole and by pole star. Latitude by altitude of sun or other heavenly body *near* the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as well as *accurate* practical working is required.

NOTE.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

1. *General Properties of Steam.*—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

2. *Steam Engine*.—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish—High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser gauge. Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors. Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
3. *Boilers*.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.
4. *Calculations*.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. *Practical working*.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.
6. *Indicator*.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—*The Marine Steam Engine*, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's *Indicator and Dynamometer*; De Pambour's *Theory of the Steam Engine*.

NOTE.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII.—Physical Geography.

The knowledge included in this subject embraces:—

- a. A general acquaintance with astronomy, so far as it relates to terrestrial phenomena.
- b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.
- c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean currents, and soundings.
- d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon commerce.
- e. Winds, including land and sea breezes, trade winds, variable winds, law of storms, cyclones, &c.
- f. Climate: physical causes which determine climate, isothermal lines, and temperature tables.
- g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.
- h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

LIST OF SCIENCE SCHOOLS AND CLASSES, showing the NUMBER OF STUDENTS under INSTRUCTION in 1863-64, and NUMBER OF MEDALS and PRIZES obtained.

Navigation Schools not examined in May, and receiving payment only under the Minute of 14th May 1864, and therefore not counted among the Science Schools, are put in italics.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Decrease.	Increase.	Number of Prizes.		Number of Medals.	
					1863-4.	1864-5.			1863.	1864.	1863.	1864.
ENGLAND.												
Almondsbury	King James' School -	Hetherington, W.	Jones, Rev. L.	Jarmain, G.	12	12	..	..	6	5	1 B.	..
Ancoats	Educational Institute	-	Oswald, John	Bowdler, A. C. Fal- lows.	32	32	..	..	..	..	..	..
Andover	British Schoolroom	Clarke, Turner P.	Footner, Richd.	Marriott, J. T.	..	16	..	..	..	..	..	..
Bacup	Mechanics' Institute	Aitken, Thos.	Newbigging, T.	Meehan, H. P.	17	27	10	..	7	11	..	..
Banbury	Cherwell School	Samuelson, B.	Cadbury, J.	Pidgeon, D.	20	17	..	3	9	23	1 B.	3 B., 1 S.
Banbury	The Laboratory, High Street	"	Cadbury, J.	Beeley, Thomas	40	11	29	..	17	..	..	..
Birmingham	Midland Institute	Wiggin, H.	Smith, Edwin	Woodward, C. J.	79	93	14	..	8	16	1 B.	1 G., 1 S., 1 B.
Bolton	Mechanics' Institute	Hick, John	Lowe, Rev. J.	Ward, Thomas	50	55	5	..	5	16	..	..
Bolton	Working Men's Institute	Hick, John	Lowe, Rev. J.	Collins, J.	..	54	..	..	..	12	..	..
Brentford	New British School	"	Cross, Chas. J.	Rowden, W. T.	..	40	..	..	..	..	..	..
Bristol	Trade School	Gale, J. Sadler	Wilkinson, J.	Coomber, T.	116	120	4	..	27	31	1 G., 3 S., 3 E.	..
Burnley	Church of England Literary Institute.	Parker, Rev. A. T.	Briggs, B. W.	E. C. Plant A. J. Gayne W. Robotham	19	37	18	..	3	9	..	..
Burnley	St. Paul's School	Shuttleworth, Sir J. K.	Sutherland, J.	Meehan, H. P.	..	43	..	..	..	..	..	..
Burnley	Grammar School	"	Sutherland, J.	Gunn, W.	..	43	..	..	..	..	..	..
Burnley	Westgate School	Masey, L.	Masey, J.	Gunn, W.	..	28	..	..	..	..	..	..
Burnley	Mechanics' Institute	Shuttleworth, Sir J. K.	Sutherland, J.	Gunn, W.	69	24	..	45	27	33	..	1 S., 1 B.
Bury	Atheneum	Hildyard, C. F.	Bunting E.	Mellor, J.	32	47	15	..	..	4	..	..
Cheltenham	Young Men's Christian As- sociation Rooms.	Downing, James	Moore, H. J.	Spriggs, C. Notcutt, W. L.	20	112	92	..	..	6	..	..

Chester - Church Crew	Mechanics' Institute Working Men's Institute Mechanics' Institute	Frost, M. Lemmon, John Barnabotham, J.	Harris, Rev. J. Jenkins, H. Stubbs, T.	Davidson, E. A. Judd, W. Davidson, E. A.	33 19 23	-	39 25 20	6 6 3	17 3 3	15 6 7	1 S. 1 G. 2 B
Droylsden	Educational Institute	Christy, Richard	Blackburn, J.	Hartley, J. Collins, J.	..	}	44	..	..	..	..
Dudley - Dukinfield	Mechanics' Institute Village Library and Read- ing Rooms.	Rude, S. Woolnough, C.	Stokes, J. Kynder, J. B.	Jones, J. Salter, E.	63 ..	-	30 16	22 ..	3 ..	3	..
Eastington	National Schoolroom	Peters, Rev. Thomas	Hooper, C. H.	Pullen, M. W.S.M. {D'Urban, Thomas, J. D. Perkins, F. P.	..	}	43	..	..	..	..
Exeter	Literary Society	Head, R. T.	Tucker, J. T.	Godin, R.	21	-	..	..	..	..	..
Exton	Boys' School	Noel, Hon. & Rev. L. G. B.	Concanon, Rev. Hodges, Sidney	Shaw, H. C.	..	-	11	..	..	..	..
Falmouth	National Schoolroom	Carrie, Wm.	Teague, Rev. J. Atkin, Rev. T.	Cooper, Wm. Cooper, Wm.	..	-	20 18	..	..	..	..
Glossop	Working Men's Institute Littlemoor Mechanics' In- stitute.	Waghbourn, T. Bu- chanan.	Fowler, Rev. H.	Jeffery, W.	54	-	44	10	15	26	..
Gloucester	Blue-coat School	Purvis, P.	Jordan, C. H.	Jones, Thomas	..	-	26	..	..	..	..
Greenwich	Rooms of Society for Diffu- sion of Useful Knowledge.	Mitchell, Rev. J. B.	Phillips, W.	Pearce, R.	20	-	13	8	..	..	..
Gulworthy	Duke of Bedford School	Akroyd, Edward	Gibb, G.	{Jarmain, G. Parke, G.	21	-}	38	17	11	9	..
Halifax	Working Men's College	Thompson, Rev. R.	Binns, John	Meaden, H. P.	35	-	19	16	20	23	1 S.
Haalingden	The Institute	Sykes, John	Rhodes, Geo. W.	Jarmain, G.	20	-	33	13	23	4	1 B.
Huddersfield	Mechanics' Institute	Collinson, W.	Wilson, R.	Scapley, Zebedee	71	-	59	..	..	..	..
Hull	Trinity House Schools	Gasill, J.	Morris, T.	Hartley, J.	10	-	24	14	..	2	..
Hulme	Christ Church Institute	Tinter, G.	Greenwood, J.	Packer, M. W.	14	-	10	4	..	2	..
Kidderminster	Mechanics' Institute	Wharton, George	Bolton, Thos.	Packer, M. W.	14	-	24	10	..	3	..
Kivner	National Schoolroom	Lincock, J. V.	Blake, B.	Ward, George	38	-	40	2	..	3	..
Leeds	Mechanics' Institute	Lampert, W. J.	Gregson, S. Leigh	{Collingwood, Dr. Samuelson, N. H. (Birkenhead, E. H.)	125	-}	37	88	23	90	3 B.
Liverpool	Free Library	Fearon, Archdeacon	Capp, C. H.	Scott, J., Spanton J.	24	-	23	1	..	5	..
Loughborough	Town Hall	Rogers, Rev. W.	Runtz, G.	Pike, R. W.	84	-	95	11	11	14	..
London:—	Bethnal Green	Handard, Rev. S.	Halliday, J.	Simpson, B.	42	-	50	12	..	2	..
Bethnal Green	St. Matthew's National School	Rev. F. D. Morris	Litchfield, R. B.	Tate, R.	4	-	7	3	..	..	..
Gt. Ormond Street	Working Men's College					-					..

* Schools established in 1864.

† **With Mechanics' Institution.**

‡ Including CornGreave.

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1893-4.	1894-5.			1893.	1894.	1893.	1894.
London—cont. Harp Alley, Farringdon Street.	British School	Curtis, J. C.	Whittard, C.	Jones, Alfred	200	50	..	150	..	17	..	..
Islington	Lower Public School	Fleming, Rev. W.	Ross, John	Howard, John	98	95	..	3	12	13	2 S.	1 G.
Kingsland	British Schools	Rogers, Rev. W.	Hoskins, W. H.	Jones, Alfred, Tate, R.	45	75	30	..	7	3	..	..
Polytechnic	Royal Polytechnic Institution	Mackenzie, Rev. C.	Cousens, J.	Giles, Ferdinand	*	14	..	..	..	..	..	..
Shadwell	Sailors' Institute	Kingsford, Rev. B.	Fieldwick, T. A.	Nelson, R. J.	32	19	..	13	..	3	..	..
Wells St.	Sailors' Home	Maudsley, Hon. Capt. R. N.	Webb, W. H.	Newton, John	252	233	..	54	..	..	..	..
Macclesfield	Mechanics' Institute, St. George's School, Sutton.	Jackson, James	Brooker, John	Wiro, A. P.	44	26	..	18	6	18	1 B.	1 G.
Macclesfield	Modern Free School	Thornycroft, J.	Brooker, John	Chadwick, J.	40	36	..	4	2	2	..	..
Manchester	Cathedral Schools	Callendar, W. R., Jun.	Huntington, Rev. G.	Collins, John	20	20	..	..	1	5	..	1 S.
Manchester	Mechanics' Institute	Scholefield, B.	Jarrett, Albert	{ Angell, J. Mellor, J. Collins, J. Plant, J. Spriggs, C. Hudson, F. Jarmain, G. Stock, W. F. K.	290	281	..	9	77	87	4 B.	4 B., 3 S.
Manchester	68, Corporation Street	Turner, W.	Noar, Wm.	Mellor, James	52	52	..	..	18	23	..	..
Marsden	Mechanics' Institute	Robinson, J. B.	Mellor, James	Jarmain, G.	15	14	..	1	..	4	..	..
Middlebrook	Mechanics' Institute	Gilkes, Edgar	Taylor, Wm.	Stock, W. F. K.	13	9	..	4	7	2	..	..
Nelson-in-Marsden	Mechanics' Institute	Ecroyd, Wm.	Waddington, J.	Clement, L. Gunn, W.	20	23	8	..	..	..	..	..
Netherton	Mechanics' Institute	Hough, Rev. George	Bentley, Buzi	Jarmain, G.	24	21	..	3	1	7	..	..
Newcastle-on-Tyne	Mechanics' Institute	Bell, J. Lowthian	Carse, Adam	Johnstone, Dr. W.	42	31	..	11	14	8	..	..
Newcastle-on-Tyne	Iron and Alkali Works School	Thompson, Rev. C.	Clapham, R. C.	Geisthous, Chas.	..	15	..	..	..	..	..	..
Newcastle-on-Tyne	Trinity House School	Taylor, Joshua	Gordon, James	Thorrie, Wm. Henry	139	165	26	..	..	..	..	..
Newton Heath	Mechanics' Institute	Fege, Wm.	Evans, George	Hardley, J.	18	18	..	..	..	..	..	..
Nottingham	Mechanics' Institute	Wild, John	Thurlow, R.	Wilson, Dr. T.	17	82	65	..	4	3	..	..
Oldham	Analytical Literary Institute	Murray, Geo. J.	Taylor, Henry	Butterworth, Thos.	30	27	..	3	..	..	..	..
Oldham	Parish Church School	Platt, T.	Walters, Rev. W.	Mellor, J.	140	85	..	64	34	32	2 B., 1 S.	1 B., 2 S.
Oldham	Lyceum	Shuttleworth, Sir J. K.	Bailey, T.	{ Ribbeck, L. C. { Mitchell, T. C.	..	72	..	..	..	..	..	..
Padiham	Trades Hall	Capel, Wm.	Sutherland, J.	Gunn, W.	12	11	..	1	..	..	..	..
Painsworth	Free School	Hill, R.	Skinner, J. W.	Pullen, Moses	24	10	..	14	4	2	..	..
Plymouth	Navigation School	..	Cumming, W. B.	Merryfield, J.	240	343	103	..	..	..	..	..

Ravenshall	-	Holly Mount School	-	Hardman, R. H.	-	King, Chas.	-	Meaden, H. P.	-	17	20	3	4	8	..
Redditch	-	Literary and Scientific Institute.	-	Fessey, Rev. G. F.	-	Millward, V.	-	Shore, T. W.	-	88	40	2	..	1	..
Salford	-	Working Men's College	-	Turner, W.	-	-	-	{ Plant, J. }	-	65	41	..	24	11	..
Slathwaite	-	Mechanics' Institute	-	Dean, Wm.	-	Pickles, Joseph	-	{ Hudson, W. }	-	12	14	2	..	2	..
Slathwaite	-	Meekes and Walker's Educational Institute.	-	Hubert, Rev. C. A.	-	Hubert, P. W.	-	Jarmain, G.	-	..	18	..	..	..	..
Slough	-	Mechanics' Institute	-	Cree, Rev. J. A.	-	Chapman, J.	-	Dorrell, J.	-	41	66	25	1	8	..
Staleybridge	-	Mechanics' Institute	-	Marland, J.	-	Newton, E. B.	-	Hudson, W.	-	..	86	..	..	..	..
St. Day	-	Girls' Schoolroom	-	Rogers, Rev. S.	-	Hawke, E. H.	-	Pearce, R.	-	18	12	..	6	1	..
St. Just	-	Mechanics' Institute	-	Hadow, George	-	Foyne, R.	-	Pearce, R.	-	15	23	7	..	..	..
Stockport	-	Mechanics' Institute	-	Leigh, Wm.	-	Robinson, S.	-	Collins, J.	-	25	40	..	6	..	..
Stourbridge	-	Grammar School	-	Hon. and Rev. W. H. Lyttelton.	-	Welch, Rev. W. J. J.	-	{ Parker, M. W. }	-	9	25	16	..	..	..
Stroud	-	Lecture Room, King Street	-	Dickenson, S.	-	Foster, Wm.	-	{ Vick, W. }	-	57	55	..	2	10	26
Tintwistle	-	National School	-	Page, James A.	-	Taylor, Peter	-	{ Pullen, M. }	-	14	11	..	8	..	..
Torquay	-	British School	-	Vivian, E.	-	Weeks, C.	-	{ Cooper, W. }	-	..	25	..	..	..	..
Truro	-	Royal Institute	-	Barham, C., M.D.	-	Mayne, J. O.	-	{ Viccars, V. }	-	..	45	..	..	..	..
Upton, St. Leonard's	-	School House	-	Hunt, C. B.	-	Bettes, Rev. J.	-	Davis, U. J.	-	30	40	10	..	1	13
Walsall	-	Grammar School	-	Jesson, R.	-	Irvine, Rev. A. C.	-	Jones, John	-	38	29	..	9	3	..
Walls	-	Mutual Improvement Society's Rooms.	-	Everett, J. G.	-	Palmer, J.	-	{ Rule, C. H. }	-	..	9	..	..	..	..
Wigan	-	Mining and Mechanical School.	-	Fergie, Rev. T. F.	-	Peace, M. W.	-	Birkenhead, E. H.	-	92	93	1	..	9	13
Wolverhampton	-	Working Men's College	-	Ulea, Rev. J. H.	-	Langley, J. N.	-	{ Jones, John }	-	16	35	19	..	7	3
Wolverton	-	Science and Art Institute	-	Russell, Rev. B. N.	-	Meadley, J.	-	{ Harrett, Rev. F. W. }	-	38	40	2	..	1	7
Woolwich	-	Royal Arsenal	-	Anderson, John	-	Keeble, W. D.	-	{ Davison, W. }	-	47	60	13	..	16	18
Yarmouth, Great	-	Navigation School	-	Steward, R.	-	Butcher, M.	-	{ Jones, Thomas }	-	146	163	17	..	..	28
SCOTLAND.															
Aberdeen	-	Mechanics' Institute	-	Watson, Robt.	-	Sinclair, James	-	{ Beveridge, Dr. R. }	-	48	34	..	14	9	2
Aberdeen	-	Navigation School	-	Cargill, J., Capt. R.N.	-	Hallas, Jas. F.	-	{ Mayer, D. }	-	245	251	6	..	..	..
Corsock	-	Girls' School	-	Sturrock, Rev. G.	-	Houston, S.	-	{ Jones, J. R. }	-	25	24	..	1	2	..
	-		-		-		-	{ Macomish, Miss M. }	-			..	..	..	..

* Schools established in 1864.

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.	Increase.	Decrease.	Number of Prizes.		Number of Medals.	
								1863.	1864.	1863.	1864.
Dundee	High School	Sturrock, J.	Cunning, A. W.	Kennedy, J.	55	45	10	..	5	..	1 S.
Glasgow	Secular School	Blackie, J., junr.	Cunliffe, R. S.	{ Mayer, J. Mayer, Mrs. McBae, J.	115	130	15	43	33	2 B., 1 S.	1 S.
Glasgow	Athenaeum	"	Cunliffe, R. S.	Macbattie, A. T.	..	21	..	..	..	..	..
Glasgow†	Andersonian University	"	Martin, G.	{ Foster, G. C. Buchanan, G.	640	662	52	3	25	1 S.	1 G.
Kilmarnock	New Public School	Aitken, Rev. James	Crawford, Robt.	Penny, Dr. F.	..	11	..	..	..	..	..
Leith	Navigation School	Lindsay, W.	Thomson, Rev. J.	Stevenson, James	305	237	68	..	1	..	..
IRELAND.											
Ballymena	District Model School	Rowen, Rev. R. W.	Given, John	Wren, Edmund	..	24	..	..	7	1 G., 2 S., 1 B., 1 S.	1 G.
Bandon	Town Hall	Doherty, R. W.	Browne, Stephen	O'Keefe, C.	..	20	..	..	..	1 B.	..
Belfast	Royal Academical Institute	Lytle, John	M.L.D.	Holden, J. S.	32	35	3	..	12	..	..
Belfast	National Model School	Lytle, John	Shepherd, W.	Smeeth, R.	33	64	..	..	..	..	..
Belfast	Navigation School	Patten, James	Nesbitt, R.	Doran, George	112	83	29	..	1	..	..
Carrikerfergus	Model School	Patten, James	Dawling, John	Stevenson, J. McN.	30	35	5	..	..	..	..
Comber	Smyth's National School	Rogers, Rev. J.	Withers, R.	Greer, W. H.	..	21	..	..	..	..	..
Drogheda	Mechanics' Institute	Mathews, J.	Grey, P. J.	Dowling, John	42	24	18	23	11	..	2 B., 1 S.
Dublin	Athenaeum	Manning, J.	Crory, W. G.	Dowling, John	..	23	..	..	..	..	..
Dublin	Christian Schools	McCabe, Rev. E.	Woodhouse, J.	Mayne, A. J.	..	190	..	..	..	..	..
Dublin	Christian Brothers' Schools	McCabe, Rev. E.	McPadden, M.	Dowling, J.	..	29	..	..	..	..	..
Dublin	Central Model School		Butler, Ed.	McCarthy, D.	35	63	28	..	..	..	..
Holywood	National Model School	Patterson, Robert, F.R.S.	Shepherd, W.	Holden, J. S.	66	55	11	..	11	..	..
Newtownards	National Model School		Osborne, A. T.	{ Harbison, M. Greer, W. H.	35	31	4	..	16	..	..
Oldcastle	Endowed School	Durbin, Rev. J. G.	O'Neill, R.	{ Beatty, J. Smyth, A.	52	115	63	..	9	..	..
Santry	Training School	West, Rev. J., D.D.	Hackett, Rev. J. W.	{ Mayne, A. J. Dowling, James	..	87	..	..	..	..	..
Waterford	Model School	Hoare, Rev. E. N.	Hardley, F. N.	{ Sullivan, M.	84	90	6	..	4	..	..
Totals					4,033	5,054	..	603	825	..	..

* Schools established in 1864.

† Not counted in the totals, as not under a certificated teacher.

TABLE showing the SUBJECTS taught at each SCIENCE SCHOOL, and also the NUMBERS in each SCHOOL.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Almondsbury	King James's School -	..	22	..	..	..	..	..	..	12	13	..	..	..	..	..	..	..	..	..	..	..	..	..
Aucoats	Educational Institute	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..
Andover	British School Room	..	..	..	..	..	..	..	..	..	..	14	..	..	..	..	..	..	..	..	..	..	..	..
Bacup	Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Banbury	Cherwell School	..	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Banbury	The Laboratory, High Street	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Birmingham	Midland Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bolton	Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bolton	Working Men's Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brentford	New British School	29	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bristol	Trade School	74	74	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burnley	Church of England Literary Institute.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burnley	St. Paul's School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burnley	Grammar School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burnley	Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burnley	Westgate School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bury	Athenaeum	34	34	34	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cheltenham	Young Men's Christian Association Rooms.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chester	Mechanics' Institute	33	13	11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Christchurch	Town Hall	..	16	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crewe	Mechanics' Institute	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Droylsden	Educational Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dudley*	Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

* Including Corringcaves.

Table showing the Subjects taught at each Science School, &c.—continued.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Dakinfield	Village Library and Reading Rooms	..	..	..	..	..	..	..	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..
Eastington	National School Room	42	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Exeter	Literary Society's Rooms	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Exton	Boys' School	..	..	..	..	..	..	..	..	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..
Falmouth	National Schoolroom	..	..	..	..	..	..	..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..
Glossop	Working Men's Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Glossop	Littlemoor Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gloucester	Blue-coat School	..	..	..	..	..	..	..	..	..	33	..	..	..	..	..	..	..	..	..	..	..	..	..
Greenwich	Rooms of Society for Diffusion of Useful Knowledge	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gulworthy	Duke of Bedford School	26	26	..	..	..	..	..	..	..	12	..	..	12	..	..	..	..	..	..	..	..	..	..
Halifax	Working Men's College	..	..	..	..	..	..	..	..	..	31	10	..	..	..	..	..	..	..	..	..	..	..	..
Hastings	The Institute	..	..	..	..	..	..	..	..	..	33	11	..	..	..	..	..	..	..	..	..	..	..	..
Huddersfield	Mechanics' Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hull	Trinity House Schools	..	..	..	..	..	..	..	..	..	24	20	..	..	..	..	..	..	..	..	..	..	..	..
Hulme	Christ Church Institute	..	..	..	..	..	..	..	..	..	10	7	..	..	..	..	..	..	..	..	..	..	..	..
Kidderminster	Mechanics' Institute	..	..	..	..	..	..	..	..	..	24	..	..	..	..	..	..	..	..	..	..	..	..	..
Kinver	Young Men's Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leeds	Mechanics' Institute	..	..	..	..	..	..	..	..	..	32	11	..	..	..	..	..	..	..	..	..	..	..	..
Liverpool	Free Library	..	..	..	..	..	..	..	..	..	15	17	..	..	..	..	..	..	..	..	..	..	..	..
Loughborough	Town Hall	16	..	..	..	..	..	..	..	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing the Subjects taught at each Science School, &c.—continued.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Slough	Mechanics' Institute	68																						
Staleybridge	Mechanics' Institute	14	80																					
St. Day	Girls' School-room																							
St. Just	Mechanics' Institute																							
Stockport	Mechanics' Institute																							
Stourbridge	Lecture-room, King Street																							
Stroud	National School																							
Tintwistle	British School																							
Torquay	Royal Institute																							
Truro	School House																							
Upton St. Leonards																								
Walsall	Grammar School																							
Wells	Mutual Improvement Society's Rooms.	9																						
Wigan	Mining and Mechanical School	80	80																					
Wolverhampton	Working Men's College																							
Wolverton	Science and Art Institute	17																						
Woolwich	Royal Arsenal	53	48																					
Yarmouth, Gt.	Navigation School				83																			
SCOTLAND.																								
Aberdeen	Mechanics' Institute																							
Aberdeen	Navigation School		17																					
Corsook	Girls' School																							

TABLE of HONORARY DIPLOMAS granted without EXAMINATION.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Brazier, Professor Collingwood Dr. Carter, R. B. Pepper, John H.	Aberdeen Liverpool Strout, Gloucestershire Polytechnic Institute, Regent Street, London.	..	..	..	..	..	..	..	..	..	1	1	1	1	..	1	1	..	..	..	..	..	..	..
		Practical, Plane, and Descriptive Geometry.	Mechanical & Ma- chine Drawing.	Building Con- struction & Naval Architecture.	Elementary Ma- thematics.	Higher Mathe- matics.	Theoretical Me- chanics.	Applied Me- chanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Che- mistry.	Organic Che- mistry.	Geology.	Mineralogy.	Animal Physio- logy.	Zoology.	Vegetable Physio- logy and Econo- my Botany.	Systematic Bo- tany.	Mining.	Metallurgy.	Navigation.	Nautical Astro- nomy.	Steam.	Physical Geo- graphy.

TABLE showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination of November 1864.

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1859 came into operation.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Abbott, Joseph Adams, George Adcock, Joseph H. Aldread, Edwin Allen, Alfred H.	Collegiate Institution, Liverpool Newcastle-on-Tyne St. Mark's College, Chelsea Training College, Battersea 14, Fernley Place, Glossop Road, Sheffield	..	..	..	..	..	..	..	..	..	1	1	1	1	..	..	..	..	..	..	..	..	..	..
		Practical, Plane, and Descriptive Geometry.	Mechanical & Ma- chine Drawing.	Building Con- struction & Naval Architecture.	Elementary Ma- thematics.	Higher Mathe- matics.	Theoretical Me- chanics.	Applied Mecha- nics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Che- mistry.	Organic Chemis- try.	Geology.	Mineralogy.	Animal Physio- logy.	Zoology.	Vegetable Physio- logy and Econo- my Botany.	Systematic Ho- tany.	Mining.	Metallurgy.	Navigation.	Nautical Astro- nomy.	Steam.	Physical Geo- graphy.

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Bramall, Henry	Rainford Collieries, near St. Helen's	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Breakwell, William	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brears, William	Tandridge School, Godstone	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Briggs, James Alfred	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Briggs, Henry	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bright, William	17, Bute Street, Cronwall Lane, Brompton.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brown, Moses	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Brown, Wm. J.	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryant, John	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burchill, Samuel H.	Navigation School, Shadwell	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
*Buckmaster, J. C.	St. John's Hill, Wandsworth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Burns, William	8, Newton Terrace, Rochester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bush, James	Training College, Cheltenham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Butterworth, Thomas	Nugget Street, Glodwick, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Button, John	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Card, William F.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cattell, Thomas E.	National School, Cortesmore, Oakham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Caulier, Jno. Wp.	12, Hindon Street, Fimlico	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chadwick, John	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chalk, Ellen M.	3, Heasman Terrace, Victoria Park	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chalk, Frank	3, Heasman Terrace, Victoria Park, N.E.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clapp, Elisabeth M.A.	Birkbeck School, Kingland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clark, Albert Chas.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clement, Leonard	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Dowling James	Model School, Waterford	Practical, Plane and Descriptive Geometry.	Machine Drawing.	Building Construction & Naval Architecture.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Dowling John	2, Upper Buckingham Street, Dublin																							
Duffy John N.	County School, Leicester																							
Dunn Henry	Training College, Westminster																							
D'Urban, Wm. S. M.	Newport House, near Exeter																							
Eardley Francis	Waterford																							
Eastley William	Trinity Schools, Ripon																							
Eborall Thomas	St. Mark's College, Chelsea																							
Edwards Thomas	8, Victoria Street, Gowan, Glasgow																							
Edwards Thomas	28, Halsey Street, Cadogan Terrace, S.W.																							
Estcourt Charles																								
Evers Henry	Charles School, Plymouth																							
Farmer James H.	Training College, Battersea																							
Farncomb Edward	Preparatory Schools, Greenwich																							
Finlay Alex. W. A.	52, India Place, Edinburgh																							
Ford Benjamin	Bolckow's Iron Works, Middlesboro'																							
Foister John S.	St. Mark's College, Chelsea																							
Foster Benjamin	Wesleyan Training College, Horseferry Road.																							
Fryar Mark	Andersonian University, Glasgow																							
Fulton Hugh	22, Brunswick Street, Euston Road																							
Gatehouse James W.	Training College, Battersea																							
Gates George	St. Mark's College, Chelsea																							
Gayne Arthur J.	Walker Alkali Works, Newcastle																							
Gelsthar Charles	Beddow Road, Chelmsford																							
Gibbs John																								
Gill James																								
Guedhill Joseph																								

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Hurst, Edwin	St. Mark's College, Chelsea																							
Hurst, Wm. F.	Knighton Street Schools, Leicester																							
Hutton, David C.	Kirk Entry, Wexford, Dundee																							
Ivcs, Wm. Field	St. John's School, Limehouse																							
Jackson, Robert	St. Mark's College, Chelsea																							
Jackson, William	Hunsingore School, Wetherby																							
Jarmain, George	East Parade, Huddersfield																							
Jeffrey, Walter	Blue-coat Hospital, Gloucester																							
Johnston, William	Mechanics' Institute, Newcastle-on-Tyne																							
Jones, Alfred	8, Shakespeare Terrace, Stoke Newington																							
Jones, Edward	Training College, Westminster																							
Jones, Eliz. S. L.																								
Jones, James R.	Yarmouth Navigation School																							
Jones, John	The Trindle, Dudley																							
Jones, John	Copper Works School, Llanelly																							
Jones, Thomas	14, Dundas Terrace, Brookhill Road, Plumstead.																							
Jones, Richard	St. Mark's College, Chelsea																							
Judd, John W.	Wesleyan School, Horncastle																							
Judd, William	High Street, Christchurch, Hants.																							
Kelly, James J.	Gladsmuir Parish School, East Lothian																							
Kennedy, John	School of Art, Dundee																							
Kerry, Isaac																								
King, Charles	Training College, Westminster																							
King, Thomas	County School, Leicester																							
Kitchen, William	Wesleyan College, Westminster																							

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Moss, Anos	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Muir, Robert	Auchincaith	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson, Robert J.	Navigation School, Shadwell	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson, R. E.	Navigation School, Shadwell	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Newton, John	Well Street Navigation School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nicholson, William	Camborne House, Ventnor	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Noble, John	Arsenal School, Woolwich	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Northey, John	15, Salisbury Street, Lisson Grove, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Notcutt, William L.	389, High Street, Cheltenham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
O'Keefe, Cornelius	Fortwilliam Upton, County Cork	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
O'Neill, Charles	Free Church School, Jamestown, Dum-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Orkney, Daniel C.	bartonshire.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Packer, Matthew W.	National School, Kinver	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Palmer, Joseph	Wells, Somerset	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Parke, George H.	10, Morningside Place, Halifax	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Parcoe, John	Green-coat School, Huntingdon	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Patchett, Isaac	Queenshead Schools, Halifax	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pearce, Richard	Maber Lodge, Portswood, Southampton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pearce, William	London Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pearshall, T. J.	Science and Art Department	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pelle, Percival B.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pepper, Charles	21, Magdalen Street, Exeter	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Perkins, Frank P.		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Perry, George W.		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pettitt, William	Woodhouse Eaves, Loughborough	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Names.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical & Machine Drawing.	Building Construction & Naval Architecture.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Saunders, Henry J.	Sunderland																							
Saunders, James	Alma Street, Luton																							
Scapling, Zebedee	Navigation School, Trinity House, Hull																							
Scotton, James	247, City Road, Hulme																							
Schofield, Jabez C.	St. Mark's College, Chelsea																							
Scott, John	Leicester Road, Loughborough																							
Seaman, Isaac	18, Cumming Street, Pentonville																							
Seyers, George	Wesleyan College, Westminster																							
Sharp, Charles J.	15A, Upper North Place, Gray's Inn Road																							
Shaw, Henry Chas.	National School, Falmouth																							
Shawcross, William	Northwood School, Stoke-on-Trent																							
Shear, Robert	Queen's Printing Office, E.C.																							
Shinn, Thomas	St. Mark's College, Chelsea																							
Shirley, James	East Lancashire and Cheshire Union of Institutes.																							
Shore, Thomas W.	St. Matthew's School, Bethnal Green																							
Simpson, Benham	Newton Heath, near Yorkville, Manchester.																							
Slater, James K.	Liverpool																							
Smart, Herbert J.	National Model School, Belfast																							
Smeeth, Rowland	St. Thomas', Charterhouse																							
Smith, Joseph H. T.	Chemical Works, Kilmarnock																							
Smith, Robert F.	Training College, Westminster																							
Smithies, Samuel	Endowed School, Oldcastle, Co. Meath																							
Smyth, Andrew	9, Great Marylebone Street, London																							
Snelus, George J.	Woodbine Cottage, Newtonmurey Road, Bray.																							
Spear, John J.																								

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised to February 1866.)

13th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1866.

Price Sixpence.

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CROMWELL ROAD, SOUTH KENSINGTON.

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Vice-President of the Committee of Council on Education, The Right Hon.

H. A. BRUCE, M.P.

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Office hours 10 till 4.

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Second-class Clerks.—A. H. Gasparini; T. Hickson, A. 2nd grade; A. A. Pierce, A. 2nd grade; A. S. Cole, A. 2nd grade; A. J. R. Trendell.

Provisional Clerks.—E. Belshaw, A. 2nd grade; W. Burt, G. Millard, S. xxiii.

Assistant Clerks.—W. H. F. Stratton, C. Comyns, C. G. Quinton.

Accountant.—A. L. Simkins.

Book-keeper.—H. W. Williams. *Assistant.*—T. A. Bowler.

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Vice Principal.—Henry Martyn Taylor, B.A., Scholar, Trinity College, Cambridge.

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Instructor in Engineering Drawing.—John Maxton.

Instructor in Practical Chemistry.—John Davidson.

Instructor in French.—M. Penon.

* The letters S and A refer to the Science and Art Certificates taken.

**SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.**

*[Important Alterations made since the last edition of the Directory are
printed in Italics.]*

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100*l.* a year. (See § xviii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and Teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given :—

Subject 1, Practical Plane and Descriptive Geometry.

„ 2, Mechanical and Machine Drawing.

„ 3, Building Construction or Naval Architecture.

„ 4, Elementary Mathematics.

„ 5, Higher Mathematics.

„ 6, Theoretical Mechanics.

„ 7, Applied Mechanics.

„ 8, Acoustics, Light, and Heat.

„ 9, Magnetism and Electricity.

„ 10, Inorganic Chemistry.

„ 11, Organic Chemistry.

„ 12, Geology.

„ 13, Mineralogy.

„ 14, Animal Physiology.

„ 15, Zoology.

„ 16, Vegetable Physiology and Economic Botany.

„ 17, Systematic Botany.

„ 18, Mining.

„ 19, Metallurgy.

„ 20, Navigation.

„ 21, Nautical Astronomy.

„ 22, Steam.

„ 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers.
(See § xv., xviii., and xix.)

2. Grants towards the purchase of apparatus, &c.
(See § xxi.)
3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv. and xviii.)

VIII. Examinations for certificates to teach any of the before-mentioned sciences are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin, Edinburgh, and Manchester if five candidates register themselves for examination in Ireland and in Scotland and in the north of England. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he or she wishes to be examined. Certificates of three grades are given in each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.* No payments can be made to a teacher on account of instruction in subjects in which he is not certificated.

Examinations
for Teacher's
Certificates.

IX. Suitable premises, with firing, lighting, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

School Pre-
mises.

* Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Local Committee. X. A Local Committee of not less than five well known responsible persons must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. (See pages 14 and 18 to 22.)

Examination of Classes under Certificated Teachers. XI. The Science and Art Department holds annually in May (see Science Form, No. 232, page 59), through the agency of the Local Committees, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men, and for them only, three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of other Classes. XII. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not at present be insisted on.

Places of
Examination.

XIV. Any persons whatever, whether taught by the certificated teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

Examination
of other
Students.

XV. The successful candidates at the May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and *fifth* class. The standard of attainment required may be raised from year to year. For the *fifth* class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited

Classification
of Results.

by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, *see a. and b.* (1) Students in Science Classes under Certificated Teachers ; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) *bonâ fide* artisans.

Other candidates, if successful, receive instead Certificates of merit recording their success.

The following are exceptions to the above rule.

- a.* Science Certificated Teachers ; and
- b.* Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be recorded in the published lists.

Queen's
Medals.

XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (*see § x. and xii.*) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the ^{Payments to Teachers.} certificated teacher on account of the instruction of students of the Artisan Classes (for definition of Artisan Class *see* Science Form No. 51, page 24) in the following manner:—

1*l.*, 2*l.*, 3*l.*, 4*l.*, 5*l.* are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced in the following ways:

1st. If the student has been successful in the same subject before such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4*l.* payment for a second class would, if the student had previously taken a fourth class, be reduced by 2*l.**

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60*l.* the excess up to 40*l.* is diminished by one quarter, the excess above 40*l.* by one half. Thus payments which on the above scale would be 100*l.* and 150*l.* will be reduced to 90*l.* and 115*l.* respectively: †—provided that the student has received 25 lessons ‡ at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not neces-

* Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

† Thus, 100, that is $60 + 40$, is reduced to $60 + 40 - \frac{1}{4}$ of 40 = $60 + 30 = 90$. 150, that is, $60 + 40 + 50$ is reduced to $60 + 30 + 25 = 115$.

‡ It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

sarily be all given in one year, but may extend over a longer period.

Form of Claim
for Payment.

XIX. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 24.)

School
Register.

XX. A school register must be kept in each subject on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for
Apparatus.

XXI. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5% to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 30.)

Travelling
Expenses of
Teachers.

XXII. The travelling expenses (second-class railway fare, and 10s. per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in
an Elementary
School.

XXIII. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. They do not apply to any instruction

in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXIV. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit such part or parts of their premises to be used for Science teaching as shall not interfere in any way with the three attendances of the Elementary School.

Use of
Elementary
School
Premises.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.	
Before 30th November.	Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.
Constantly - - -	To visit the School and see that the Register is kept from day to day, and that everything is regular.
Before 1st January	To carefully fill in and send to the Department Form No. 120.
Before 31st March	To send Form No. 119 applying for examination in May.
Before 24th April -	To see that Form No. 91 is hung up in the School-room.
On the 27th April	If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate <i>at once</i> to the Department.
During the May examinations.	The examination papers for each evening will leave London by the night mail two evenings before, <i>i.e.</i> , Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent <i>at once</i> to the Department.
On the evening of examination.	The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.
After the May examinations.	On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.
	To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.
	To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50*l.* per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1866 examination two of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grade Queen's Prize, in any subject	-	-	9 marks.
To a 2nd " " " "	-	-	7 "
To a 3rd " " " "	-	-	5 "
To a 4th " " " "	-	-	3 "
To a 5th " " " "	-	-	1 "

and in addition—

For a gold medal	-	-	10 "
For a silver medal	-	-	7 "
For a bronze medal	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

FORM of APPLICATION for the ROYAL EXHIBITIONS to the ROYAL SCHOOL OF MINES, Jermyn Street, London, and the GOVERNMENT SCHOOL OF SCIENCE, Dublin.

The following candidates at the recent May Examinations are candidates for the Royal Exhibitions at the* _____

and they are either—

1. Under 21 years of age.
2. Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
3. Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.

a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.

b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coastguards, etc.

c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.

4. That they are entitled to be considered as a special case on the following grounds:—
- _____
- _____

We hereby certify that the above particulars are correct.

 _____ { *Chairman or Secretary.†*
 _____ { *Two members of the*
 _____ { *Committee.†*

* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.

† Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS
AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.

- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artizans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.

5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM of APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- [f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
- g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
- h. It is absolutely necessary that at least two such responsible persons should agree to act.
- i. The Committee must consist of a Chairman, Secretary, and at least three other Members.
- k. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
- l. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
- m. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1*l.* annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1*l.* in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
- n. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
 <i>Chairman.</i>		
 <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to resign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS,

To be made on its establishment, and annually (before the 1st January) of its continuation.

Name of Town _____

Place, as Mechanics' Institution, &c., in which the Classes are held _____

Name of Street, No., &c. _____

Name of Teacher or Teachers _____

Their private addresses _____

Total No. of individual Students _____

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)

SCIENCE FORM, No. 119.

APPLICATION FROM

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

Number of students under instruction during the year } Number intending to present themselves for examination } Number intending to present themselves for examination } not belonging to the class }	Practical, Plane, and Descriptive Geometry.	I.	Mechanical and Machine Drawing.	II.	Building Construction.	III.	Elementary Mathematics.	IV.	Higher Mathematics.	V.	Theoretical Mechanics.	VI.	Applied Mechanics.	VII.	Acoustics, Light, and Heat.	VIII.	Magnetism and Electricity.	IX.	Inorganic Chemistry.	X.	Organic Chemistry.	XI.	Geology.	XII.	Mineralogy.	XIII.	Animal Physiology.	XIV.	Zoology.	XV.	Vegetable Physiology and Economic Botany.	XVI.	Systematic Botany.	XVII.	Mineralogy.	XVIII.	Metallurgy.	XIX.	General Navigation.	XX.	Nautical Astronomy.	XXI.	Steam.	XXII.	Physical Geography.	XXIII.
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Total number of students * under instruction during the year

Total number of students * intending to present themselves for examination

Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

AN ACCOUNT OF TRAVELLING AND PERSONAL EXPENSES DISBURSED AND CHARGED BY

Thomas Jones,

From the *2nd November 1860*, to the *4th November 1860*.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £1 13s. 8d. is due to me for the services stated.

Thomas Jones.

[Name and title of officer to be specified.]

Teacher of Chemistry in———School of Brighton.

Date upon which the services were Performed.	In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.	TOTAL AMOUNT.
<i>1860.</i>	<i>To attend examination in Chemistry held at South Kensington on 3rd November 1860.</i>	
<i>2nd November.</i>	<i>Railway fare from Brighton to London (2nd Class) - - - - - 0 6 6</i>	
<i>3rd November.</i>	<i>Omnibus fare to and from Charing Cross and South Kensington - - - - - 0 0 8</i>	
<i>4th November.</i>	<i>Railway fare from London to Brighton - - - - - 0 6 6</i>	
	<i>3 days' personal allowance at 10s. - - - - -</i>	<i>0 13 8</i>
		<i>1 0 0</i>
		<i>1 13 8</i>

NOTE.—Should the successful candidate live in London, Edinburgh, &c. or near enough to get home at night, he is only to be allowed 8s. per diem besides his travelling expenses.

Examined and approved,

Secretary.

Received this _____ day of _____ 18____, the sum of _____ pounds _____ shillings and _____ pence, in payment of the above amount.

£ _____

On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _____ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.

- a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c.
- b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so such as shopkeepers (who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c.
- c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c.

We certify to the best of our belief—

- (1). That he has given them (25) lessons at least during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
- (3). That the following particulars on which the Teacher grounds his application are correct.

Secretary.

**Two mem-
bers of
Committee.**

I hereby certify that the following particulars are correct.

Teacher.

NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES.

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success with the proper deductions.

Under the names of students in category "c" a line must be drawn.

[illegible]

**The Secretary,
Science and Art Department.**

(The following particulars will be filled up at South Kensington.)

Examined and found correct to the extent of

Approved _____ day of _____ 186____
 _____ day of _____ 186____

[SPECIMEN.]

Science Form, No. 51.
South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from *John Smith*, Science Teacher in the *Science School*
or Institution at *Midhurst* for payment.

On behalf of the Committee of Management of this School, We do
hereby certify :—

- (1.) That *Mr. J. Smith* has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;
- (2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;
- (3.) That the undermentioned students are *artizans or operatives* * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, { Two mem-
James Robinson, { bers of
 { Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Position in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade		
<i>Adams</i> ,	<i>James</i> ,	22	<i>Carpenter</i> ,	<i>X.</i>	<i>1st</i>	—	£ s.
"	"	"	"	<i>XI.</i>	<i>2nd</i>	<i>4th</i>	5 0
"	"	"	"	<i>XIV.</i>	<i>Pass</i>	—	1 0
<i>Barber</i> ,	<i>John Wm. Henry.</i>	14	<i>Butcher (f)</i>	<i>X.</i>	<i>1st</i>	<i>2nd</i>	0 10
"	"	"	"	"	"	"	0 10
<i>Smith</i> ,	<i>William</i> ,	12	<i>Baker (f)</i>	<i>XI.</i>	<i>4th</i>	—	2 0
"	"	"	"	<i>I.</i>	<i>1st</i>	—	5 0

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3 when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _____ Secretary of the Local
Committee for the Science School or Class at _____
for payment of allowance for duties connected with the School, and for
superintending the examination.

Sir,

*Being entitled to payment according to the regulations of the
Science "Directory,*" for duties connected with the Science Class at
_____ and for superintending the arrangements
for carrying out the examinations on _____ the following days
in May 186 , I request that the sum of £ _____ may
be paid to me, being the authorized fee.*

Dates of Examination.	Dates of Examination.	Dates of Examination.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

I am, Sir,

Your obedient Servant,

The Secretary,

Science and Art Department.

**CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS,
&c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES
(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),† IN
PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.**

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

* £1 annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5*l.*

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

"1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

"2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

"3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

No. 1 application to be filled in by Requisitionist, with full particulars.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

Having	Male	Female	(*) Pupils (Artizans or Operatives) of the Science Class.
(*) Erase the words that do not apply.			(*) Scholars or Members of Poor School or Mechanics Institute.
and			
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____ at _____
per _____ Signature of Requisitionist.
Dated this _____ day of _____ 186 .

No. 2 to be filled in by the Department.

2. Requisition sent to M _____ Agent,
this _____ day of _____ 186
and authority given for the supply of Articles to the extent _____
of _____
Net Sum - - - - -

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

No. 3 to be filled in by agent on transmission of the invoice.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186
Articles (Retail Price) - - - - £ _____
Deduct as above, - - - - -
Aid by Department - - - - -
Add, for packing - - - - -
Total to be paid by Requisitionist - - - - -

Nos. 4 and 5 to be filled in by agent.

4. Amount £ _____ received from schools this _____ day of _____ 186 .
Agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 .
Agent.

No. 6 to be filled in by Requisitionist.

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 .
Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

* 3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day before that fixed for the examination.

* 7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

* 8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

* 9. When the candidates are seated and the papers given out, the Committee will see that the candidates commence by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room,‡ except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed. Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out.§ If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

† When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except in the drawing examination, when drawing instruments are allowed.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, *i.e.*, pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But *nothing must be torn off the form.*

class should attend before the examination to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination begins it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.*

* 13. The examination papers being given out no candidate must be allowed to return after having once left the room.† On a candidate leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures.	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

* Should the teacher of the class wish to compete at this examination for the Royal Exhibitions of the Royal School of Mines, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

† It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFICATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guidè to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

Any certificate obtained at the examination may be raised, by re-examination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

- Group I. - Geometrical Drawing, &c. Prof. T. Bradley.
 „ II. - Mechanical Physics - Rev. B. M. Cowie, M.A.
 „ III. - Experimental Physics - Prof. Tyndall, F.R.S.
 „ IV. - Chemistry - - - Prof. Hofmann, F.R.S.
 „ V. - Geology - - - Prof. Ramsay, F.R.S.
 Mineralogy, &c. - - Prof. W. W. Smyth, M.A., F.R.S.
 „ VI. - Zoology - - - Prof. Huxley, F.R.S.
 „ VII. Botany - - - Edwin Lankester, M.D., F.R.S.
 Navigation and Nautical J. Riddle, F.R.A.S.
 Astronomy.
 Physical Geography - Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published :-

- Lecture I. - Vegetable Physio- Edwin Lankester, M.D., 3rd February.
 logy and Econo- F.R.S.
 mic Botany.
 Lecture II. Mechanical Physics Rev. B. M. Cowie, B.D. 10th February.
 Lecture IV. Mining - - - W. W. Smyth, M.A., 24th February.
 F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* and the *vernier* subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.
6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 \pm b^2}$, &c.

7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term *projection*, and of the necessity for it, in order to express graphically, on a surface, *solids* of any kind; the distinction between *orthographic* and *perspective projections*; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

Why the projections, of any solid consisting of a combination of geometric forms, on two or three *co-ordinate planes* are necessary to show the form and dimensions of that solid.

Meaning of the terms *plan*, *elevation*, *profile*, *section*. The principle of the representation of *surfaces* by the projections of their generators, or of equi-distant horizontal sections termed *contours*. The direction and inclination of an indefinitely extended plane given by its *contours*, or by its *traces* on any two co-ordinate planes.

These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.

A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—

1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry. Text-Books for Practical Plane Geometry.—Bradley's *Geometrical Drawing*; Burchett's *Practical Geometry*; *Practical Geometry, Linear Perspective and Projection* (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's *Geometrical Drawing*; Hall's *Elements of Descriptive Geometry for Students in Engineering*.—Heather's *Descriptive Geometry*. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—*Elémens de Géométrie Descriptive*, par S. F. Lacroix; *Traité de Géométrie Descriptive*, par Levebure de Fourcy;

Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; *Bardin's Works on Descriptive Geometry*.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bonâ fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. *Arithmetic generally.*
2. *Geometry.*—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.
3. *Algebra.*—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple

equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.

4. *Plane Trigonometry*.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and *vice versa*. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of $90^\circ, 45^\circ, 60^\circ, 30^\circ, 180^\circ, 120^\circ, 150^\circ$, &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulae for multiplication and division of angles, viz., sine, cosine,

tangent, &c., of $(A \pm B)$, $2A$, $3A$, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in

terms of $\frac{A+B}{2}$ and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers, and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulae for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to *pass*, a competent knowledge of the following alone will be required:—

- (1.) Geometry. The first book of Euclid.
- (2.) Algebra, to simple equations and problems (inclusive).
- (3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain an honourable mention:—

- (1.) Geometry. The first three books of Euclid.
- (2.) Algebra, to quadratic equations.
- (3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

1. *Algebra*.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.
 2. *Plane Trigonometry*.—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.
- Spherical Trigonometry*.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connection between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates ; locks ; water-wheels ; turbines ; water-pressure engines ; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended:—Willis's *Mechanism* ; Baker's *Elements of Mechanism* ; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics* ; Goodeve's *Elements of Mechanism*.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated ; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds ; of pitch ; of harmony and discord ; to commit to memory the rates of vibration of the several notes of the gamut ; to be able to make sonorous vibrations visible by means of glass plates and membranes ; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light ; to be able to state the laws of both ; to explain what is meant by total reflection ; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it ; why a stick appears bent when dipped obliquely into water ; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex ; to describe the characters of their images, whether erect or inverted ; magnified or reduced ; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coërcive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: *Oxygen*. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of carbonate of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese. *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. *Nickel*. *Chromium*. *Zinc*. *Cadmium*. *Copper*. *Lead*. Manufacture of white lead.

Bismuth. *Mercury*. *Tin*. *Arsenic*. Course of analysis in cases of poisoning.

Antimony. *Silver*. *Gold*, and *platinum*. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Iron spoon.	Platinum wire and foil.
Metal filter stand.	Tongs.	Funnels.
Wash bottle containing distilled water.	Pestle and mortar.	Cut filters.
Spirit lamp.	Porcelain dishes.	Sulphuretted hydrogen apparatus.
Black blowpipe.	Watch glasses.	Platinum crucible.
Charcoal for blowpipe experiments.	Porcelain crucible.	Herapath's blowpipe.
	Triangles.	Stirring rods.
	Test tube cleaner.	

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Phosphate of sodium.	Acetic acid.
Hydrochloric acid.	Chloride of barium.	Hydrofluosilicic acid.
Nitric acid.	Chloride of calcium.	Oxalate of ammonium.
Hydrosulphuric acid.	Lime water.	Acetate of lead.
Potassa.	Sulphate of calcium.	Sesquichloride of iron.
Ammonia.	Sulphate of potassium.	Ferrocyanide of potassium.
Chloride of ammonium.	Sulphate of magnesium.	Chloride of platinum.
Sulphide of ammonium.	Chromate of potassium.	Nitrate of silver.
Carbonate of ammonium.	Oxalic acid.	
	Tartaric acid.	

In the solid state.

Carbonate of sodium.	Borax.	Blue and red litmus paper.
Nitrate of potassium.	Lime.	
Cyanide of potassium.	Sulphate of iron.	

Subject XI.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines : their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books. — Graham's *Elements of Chemistry*, Miller's *System of Chemistry*, Fownes' *Manual of Chemistry*, Gregory's *Outlines of Chemistry*, Abel and Bloxam's *Handbook of Chemistry*, Galloway's *Qualitative Analysis*.

Subject XII. —Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.
3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.
4. Volcanoes and volcanic phenomena.
5. The theory of central heat.
6. Elevation and depression of land.
7. The ordinary mineral substances that enter into the composition of rocks.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.
2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-stones, limestones, and marbles.
3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.
4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.
5. The new red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits, rock salt, and brine springs.
6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.
7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.
8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.
9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.
10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
11. Crag. Its subdivisions, chief fossils, phosphatic remains.
12. Disturbance and denudation of strata.
13. Unconformities, faults, and fractures.
14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
15. Water-bearing strata, and underground drainage. Artesian and other wells.
16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.
17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.
19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.

Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*.

Subject XIII.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity; 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.
- E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.
- G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London. 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied

more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood on the *Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death :—1st, as a part of life ; *e.g.* moulting, shedding of skin and teeth. 2nd, as opposed to life ; *e.g.* sloughing and mortification.

General death :—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes :—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the foetus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms, classes, and orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions ; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia, Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—*Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina*.

iii. Starfishes, sea urchins, and *Holothuræ* ; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster, Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms ; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lumbricus, Hirudo, Distoma, Tænia, Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

metamorphosis. The water flea as exemplifying a sexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Libellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells" (*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodilus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implantal mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*,

Cervus, Bos, Ovis, Felis, Phoca, Phocaena, Dasypus, Halmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's *Animal Physiology*, Bohn, 1859; Dr. Kirke's *Manual*; Andrew Combe's *Physiology applied to Health and Education*. For Zoology.—Dallas's *Natural History of Animals*; Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Green's *Manual of the Protozoa*.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants.. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.
11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Algæ*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpacæ*, *Cannabinaceæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hōp. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*.
16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
18. *Labiata*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.

22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellatæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbelliferæ*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Æthusa*, *Oenanthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Crucifereæ*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alharia*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for; description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different

classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, traunming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's *Report on Cornwall and Devon*. Greenwell's *Treatise on Mine-Engineering*. Dunn on the *Winning and Working of Collieries*. Hedley on *Colliery Working and Ventilation*. Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines*. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, con-

ductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of Nickel; modes of extraction, generally by a com-

ination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores,

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass,'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. *Elementary Principles*.—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale. Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

NOTE.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples.

For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon *below* the pole and by pole star. Latitude by altitude of sun or other heavenly body *near* the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as well as *accurate* practical working is required.

NOTE.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To “pass,” a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

For “honourable mention,” the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

1. *General Properties of Steam.*—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

2. *Steam Engine*.—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish—High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser gauge. Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors. Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.

3. *Boilers*.—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.

4. *Calculations*.—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. *Practical working*.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.
6. *Indicator*.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—*The Marine Steam Engine*, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's *Indicator and Dynamometer*; De Pambour's *Theory of the Steam Engine*.

NOTE.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII.—Physical Geography.

The knowledge included in this subject embraces:—

- a. A general acquaintance with astronomy, so far as it relates to terrestrial phenomena.
- b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.
- c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean currents, and soundings.
- d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon commerce.
- e. Winds, including land and sea breezes, trade winds, variable winds, law of storms, cyclones, &c.
- f. Climate: physical causes which determine climate, isothermal lines, and temperature tables.
- g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.
- h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS
AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May:—

1. That there shall be two examination papers in each subject; one of which (the first) will be an easy paper, the other (the second) more difficult.

2. That the candidate shall be allowed to select questions out of either the first or the second paper; but not out of both.

3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.

4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80* marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.

* These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS and CLASSES, showing the NUMBER of STUDENTS under INSTRUCTION in 1865-66, and NUMBER of MEDALS and PRIZES obtained.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
									1864.	1905.	1864.	1865.
ENGLAND.												
Accrington	Mechanics' Institution	-	Ratcliffe, Wm.	Gunn, W.	21	21	..	..	..	..	..	..
Alderley Edge	Day School Room	Confordine, Rev. J. W.	Bailton, G. W.	{ Slater, James K. } { Jones, Thomas }	20	20	..	..	..	..	..	..
Almondbury	King James' Grammar School.	Dyson, Edward	Jones, Rev. Lewis	Jarmain, George	12	10	4	..	5	1	..	..
Andover	Mechanics' Institution	Bracker, Henry F.	Footner, Richd.	Marriott, J. T.	16	34	18	..	2	..	..	..
Ardwick	Chancery Lane Educational Institution.	Mayson, J. S.	Lawton, Thomas	Butterworth, Thos.	8	8	8	..	..	..	..	..
Ashby-de-la-Zouch	Mutual Improvement Society's Rooms.	Smith, H. E.	Dalby, John	Gibson, George H.	34	34	34	..	..	..	..	..
Ashton-under-Lyne	Mechanics' Institution	Mason, Hugh	Newbigging, F.	Butterworth, Thos.	16	16	16	..	..	..	..	..
Bacup	Mechanics' Institution	Aitken, Thos.	Shore, Thomas W.	Shore, Thomas W.	38	11	11	..	9	..	..	..
Banbury	British School Academy	Harlock, John	Beale, J. H.	Beale, J. H.	27	20	20	..	..	..	..	..
"	"	Harlock, John	Cadbury, James	Wilson, Alexander	8	8	8	..	..	..	..	..
Birmingham	Midland Institute	Martineau, T.	Smith, Edwin	Woodward, C. J.	93	87	6	16	19	{ 1 G., 1 S., 1 B. }	..	..
Blackburn	Mechanics' Institution	Thompson, James	Hand, Thomas	Gunn, William	15	15	15	..	..	..	..	..
Bodmin	Literary Institution	Collins, C. M. E.	Phillips, Josias	Downing, Sampson	20	20	20	..	4	..	..	..
Bolton	Bridge Street School	Cannon, W. W.	Marsden, Peter C.	Ward, Thomas	50	50	50	..	..	..	..	..
"	Mechanics' Institution	Hick, John	Lowe, Rev. J.	{ Mellor, James } { Spriggs, C. } { Collins, J. }	55	89	34	..	16	14	..	1 B.
"	Independent Methodists' School.	Winterburn, Geo.	Vickers, James	Collins, John	34	34	34	..	..	..	..	..
"	Holy Trinity Working Men's Institution.	Hick, John	Lowe, Rev. J.	Collins, J.	24	24	30	12	10	..	..	..
Bristol	Diocesan Trade School	The Rev. Canon Moseley.	Wilkinson, John	{ Coomber, Thomas } { Leaper, A. } { Plant, E. C. }	120	120	..	..	31	97	{ 4 G., 2 S., 4 B. }	..
Burnley	Church of England Literary Institute.	Parker, A. Townley	Briggs, Benjamin W.	{ Shore, T. W. } { Gunn, W. } { Pickup, W. }	37	70	33	..	9	13	..	1 G
"	Fulledge Wesleyan School	Butterworth, John	Butterworth, Thomas	Healey, Thomas	19	19	19	..	..	..	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction. 1864-5, 1865-6.	Increase.	Decrease.	Number of Prizes.		Number of Medals.	
								1864.	1865.	1864.	1865.
Kidderminster	School of Art -	Brinton, John -	Harvey, J. K. -	Packer, M. W. -	10	34	24	2	2	..	..
Kilmer	National Schoolroom	Wharton, George -	Bolton, Thomas -	Packer, M. W. -	24	23	..	11	8	..	..
Leeds	Mechanics' Institution	Oxley, Henry -	Blaker, Barnett -	Ward, George -	40	83	7	81	10	..	..
Leicester	St. Martin's School and Ashwell Street School.	Vaughan, Rev. D. J. -	Jones, H. S. -	Atkins, Edward -	..	34	34	..	6	..	..
Liverpool	Free Library -	Samuelson, James -	Gregson, S. Leigh -	Birkenhead, E. H. -	37	28	9	20	13	3 B.	1 G.
Llanelli	Copper Works School -	Nevill, C. W. -	Davies, John -	Jones, John -	..	51	31	..	..	..	..
London -	Birkbeck Schools -	Tidcombe, Rev George H.	Rintz, George -	Pike, Robert W. -	95	109	14	14	6	..	..
Bethnal Green	St. Matthew's School	..	Halliday, J. -	Simpson, B. -	80	31	1	2	2	..	..
Camden Town	Camden Hall -	..	Waterman, O. -	Snelus, George J. -	7	88	88	..	6	..	..
Gt. Ormond Street	Working Men's Institution	..	Goslin, John -	Crowe, William -	..	24	24	..	1	..	..
Homerton	Parochial School -	Godding, Rev. J. -	Ross, John -	Howard, John -	95	112	17	13	15	1 G.	1 G., 1 S., 1 B.
Ilalington	Lower Public School	Fleming, Rev. W. -	Hoskins, W. H. -	{ Tate, Ralph Bithell, Richard Gregson, A. Snelus, G. J. - } { Coles, F. J. - }	75	70	..	5	5	..	1 S.
Kingaland	North London School of Science.	Aveling, Thos. -	Cousens, James	Newton, J. -	14	37	..	23	6	..	..
Polytechnic	Royal Polytechnic Institution	Mackenzie, Rev. C. -	Webb, W. H. -	Scott, John -	228	243	15	..	..	..	1 B.
City of London	Sailors' Home -	Maude, Francis, Captain, R.N.	Marshall, J. M. -	{ Wire, Alfred P. & Jackson, John - }	23	18	..	5	5	..	..
Loughborough	The Institute	Herrick, W. P. -	Brooker, John -	Jackson, John -	26	26	..	18	..	1 G.	..
Macolesfield	Mechanics' Institution	Arthy, Rev. W. E. B.	Brooker, John -	Collins, John -	36	33	3	2	4	1 S.	..
Manchester	Modern Free School -	Callendar, W. Ro- main, Jun.	Huntington, Rev. G.	{ Ancell, J. - Collins, J. - Mellor, J. - Spriggs, G. - }	20	25	5	..	..	..	..
Manchester	Cathedral Schools -	..	..	..	..	..	..	..	..	..	..
"	Mechanics' Institution	Bowker, W. (the Mayor.)	Jarrett, Albert -	Hudson, Fearnside -	231	238	12	87	104	3 S., 4 B., 3 S., 2 B.	..
"	Corporation Street -	Turner, Wright -	Near, William -	Stock, H. P. K. -	53	53	1	23	14	..	1 S., 1 B.
Middlebro'	Mechanics' Institution	Gilkes, Edgar -	Taylor, Wm. -	Wheeler, George H. -	9	8	1	2	4	..	..
Middleton	National School	Dunford, Rev. R. -	Ward, Rev. C. B.	Clement, Leonard -	..	14	..	..	..	..	..
Nelson-in-Marsden	Lomeshaye Mills	Ecroyd, Wm. -	Waddington, J. -	..	23	34	6	..	10	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1864-5.	1865-6.			1864.	1865.	1864.	1865.
Upton, St. Leonard's	School-room	-	Betts, Rev. J.	Davis, Uriah J.	40	37	..	3	12	1	..	..
Walsall	-	-	-	-	-	-	-	-	-	-	-	-
West Bromwich	Christian Institution	-	Ward, Henry	Sutcliffe, Henry	29	15	15	..	3	2	..	..
Wigan	Mechanics' Institution	-	Peace, M. W.	Birkenhead, R. H.	53	31	..	52	12	4	1 B.	..
Wolverhampton	Mowbray House School	-	Langley, J. N.	Jones, John	35	23	..	10	3	6	..	..
Wolverton	Sciences and Art Institution	-	Meadley, J.	Stone, Wm.	40	43	3	..	7	10	..	..
Woolwich	Mechanics' Institution, Royal Arsenal.	-	Keeble, W. D.	Hargreaves, Rev. S.	60	56	..	4	18	25	2 S.	1 B.
"	National School	-	Wilson, James	Jones, Thomas	..	23	..	..	..	3	..	1 S.
Yarmouth, Great	Navigation School	-	Butcher, M.	Snelus, G. J.	163	139	..	24	..	2	..	..
York	Popular Institution	-	Hall, R.	Stockton, W.	..	90	90	..	..	..	..	..
				Brown, J.	..	..	..	..	..	..	..	..
				Crawley, S.	..	..	..	..	..	..	..	..
SCOTLAND.												
Aberdeen	Mechanics' Institution	Matthews, James	Sinclair, J.	Braizer, J. S.	34	92	58	..	2	1	1 S.	..
"	Navigation School	-	-	Mayer, D.	-	-	-	..	..	..	..	..
Corsock	Girls' School	Sturrock, George	Kellas, Jas. F.	Beveridge, Dr.	251	235	34	..	..	..	..	..
Dundee	High School	Sturrock, John	Houston, S.	Jones, J. R.	24	12	..	12	2	7	..	..
Glasgow	Secular School	-	Cumming, A. W.	Macomiah, Margaret	45	53	7	..	5	8	1 S.	..
"	Athenaeum	-	Cunliffe, Rich. S.	Kennedy, John	130	150	20	..	33	27	1 S.	..
"	Andersonian	-	-	Mayer, J.	21	31	10	..	..	..	..	..
Kilmarnock	New Public School	Altken, Rev. James	Crawford, Robt.	Mayer, Mrs.	662	622	..	..	25	15	1 G.	1 S., 2 B.
Leth	Navigation School	Lindsay, Wm.	Thomson, Rev. J.	McRae, J.	11	20	9	..	..	2	..	..
				Mechattie, Alex. T.	237	219	..	13	1	..	..	..
IRELAND.												
Ballymena	National School	Loran, Rev. R. W.	Lynch, Rev. John	Black, Robert	..	18	13	..	..	..	..	..
Barbridge	Literary and Mutual Improvement Society.	Reilly, James A.	Black, Alexander	-	..	..	..	..	..	..	..	..

Belfast	Royal Academical Institute	Lyth, John	Nesbitt, R.	McNeill, James	35	11	11	13	8	..	..
"	Rosemary Street National School	Lyth, John	Nesbitt, R.	Barkle, Robert	..	90	30	..	..	..	..
"	Great George Street	"	Shepherd, Wm.	Smeeth, Rowland	64	43	21	..	11	..	..
"	Model School	"	Moore, G. L.	Wren, Edmund	23	23	23	..	..	..	..
"	Navigation School	"	Nesbitt, R.	Doran, George	83	73	10	1	3	..	..
Carrikerigua	Model School	Birnle, T. M.	Nesbitt, R.	Stevenson, J. McN.	35	50	15	..	1	..	..
Comber	Smyth's National School	Rogers, Rev. John	Withers, Robt.	{ Greer, W. H. }	21	38	17	..	..	..	..
Drogheda	Athenaeum	Manning, Joseph	Orry, W. Glenny	Dowling, John	24	26	..	3	13	18, 2 B.	1 B.
Dublin	Christian Brothers' School	"	Woodhouse, John	Mayne, Arthur J.	29	20	..	170	20	..	18, B
"	Christian Schools	"	Price, Newton	{ Lyons, M. }	190	22	..	..	..	..	..
Dundalk	Free Library	Neville, John	"	{ Graham, M. M. }	..	22	..	..	..	..	..
Holywood	"	"	"	"	55	..	..	11	6	..	..
Larne	North End National School	McKay, Rev. C. E.	Eccles, Wm.	{ Stevenson, J. McN. }	..	13	13	..	..	..	..
"	Model School	"	Eccles, Wm.	{ Hay, W. }	..	23	23	..	..	..	..
Newtownards	Model School	Moore, Rev. H.	Caborne, A. T.	Harbison, M.	31	87	..	16	39	..	..
"	Model School	Pooler, Rev. J. G.	Caborne, A. T.	{ Greer, W. H. }	..	..	..	..	..	..	..
Oldcastle	Endowed School	Durbin, J. G.	O'Neill, Richard	{ Beatty, J. }	115	140	25	9	21	..	2 B.
"	"	"	"	{ Smyth, A. }	..	..	..	..	..	..	..
Portadown	Thomas Street National School	Sherrington, T. A.	Appelbe, Rev. W. P.	MacMillan, Wm.	..	36	36	..	..	..	..
Portaferry	National School	Filson, Alex. B.	Orr, John	Begley, Geo. E.	..	28	28	..	..	..	..
Santry	"	West, The Very Rev. J.	Hackett, Rev. J. W.	Mayne, A. J.	87	64	..	23	37	..	..
Trim	The Model School	Lightburne, H.	Connell, E. A.	Freehill, M.	..	46	..	..	..	..	..
Tullamore	Church Street National School	Gunning, Robert	Bradley, J. A.	Macgowan, F. M.	..	23	23	..	..	..	..
Waterford	Model School	Hoare, The Very Rev. E. N. Dean of Waterford.	Cewet, James	Dowling, James	90	37	..	53	4	7	..

* Schools established in 1863.

TABLE showing the SUBJECTS taught at each SCIENCE SCHOOL, and also the NUMBER of STUDENTS in each SUBJECT.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical Plane Geometry.	Mechanical and Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Accrington	Mechanics' Institution	14	14						13	19	19	8												
Alderley Edge	Day School-room																							
Almondsbury	King James's Grammar School.																							
Andover	Mechanics' Institution																							
Arwick	Chancery Lane Educational Institute.																							
Ashby-de-la-Zouch	Mutual Improvement Society's Rooms.	8	8																					
Ashton-under-Lyne	Mechanics' Institution	16	16																					
Bacup	Mechanics' Institution																							
Banbury	British School																							
"	Academy				8																			
Birmingham	Midland Institution				85																			
Blackburn	Mechanics' Institution																							
Bodmin	Literary Institution								9	20	50	20												
Bolton	Bridge Street School								16	16	16	15												
"	Mechanics' Institution	56	50	20							84	15												
"	Independent Methodist's School.																							
"	Holy Trinity Working Men's Institute.										18													
"	Diocesan Trade School																							
Bristol	Church of England Literary Institution.	70	64	49					44	34	66	66												
Burnley	Fulledge Wesleyan School		15		20						15													
"																								

ENGLAND.

Table showing the Subjects taught at each Science School, &c.—continued.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economic Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Camden Town	Camden Hall	..	..	..	..	..	..	..	..	..	47	..	..	..	7	..	..	..	..	18	..	..	..	..
Great Ormond St.	Working Men's Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Harp Alley	Parochial School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Homerton	Lower Public School	..	..	..	..	..	..	..	..	100	63	..	..	..	..	..	..	..	..	..	..	..	..	..
Ilkington	North London School of Science.	31	..	..	..	..	..	..	..	9	19	..	9	7	..	..	..	..	..	..	..	..	..	..
Kingsland	Royal Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polytechnic	Milk Street, Cheapside	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
City of London	Sailor's Home	..	..	..	..	..	..	..	..	10	11	..	..	..	..	..	..	..	..	..	..	..	..	..
Well Street	The Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Loughborough	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maclesfield	Mechanics' Institution	..	..	..	..	..	..	..	7	..	25	..	..	..	..	..	..	..	..	..	..	..	..	..
Macdlesfield	Modern Free School	..	..	..	..	..	..	..	..	..	33	..	..	..	..	..	..	..	..	..	..	..	..	..
Manchester	Cathedral Schools	..	..	..	..	..	..	4	6	6	10	..	6	..	..	..	..	..	..	..	..	..	..	..
Manchester	Mechanics' Institution	144	..	..	..	..	..	..	..	..	80	120	..	..	..	..	..	..	..	..	..	..	..	..
Manchester	Corporation Street School	..	100	79	..	..	..	10	50	80	80	23	..	..	..	..	..	..	..	..	..	..	..	..
Middleborough	Mechanics' Institution	..	..	..	..	..	..	..	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	..
Middleton	National School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson-in-Marsden	Lomeshaye Mills	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Newport	The Athenaeum and Mechanic's Institution.	10	10	..	6	..	..	..	..	19	..	..	33	..	..	..	..	..	..	..	..	..	..	..
Newton Heath	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
North Ormesby	The Church Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nottingham	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oldham	Parish Church School	44	35	84	..	..	12	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oldham	Science and Art School	80	74	7	11	..	..	..	..	..	..	..	37	..	..	..	..	..	..	..	..	..	..	..

TABLE of HONORARY DIPLOMAS granted without EXAMINATION.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Brazier, Professor	Aberdeen	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carter, R. B.	Stroud, Gloucestershire	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Collingwood, Dr.	Liverpool	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Denman, Rev. J. G., M.A.	58, Newport Terrace, Bolton	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Foster, C. Le Neve	Royal Institution, Truro	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Henslow, Rev. G.	10, South Crescent, Bedford Square, W.C.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.
McCrea, Dr. John	10, College Street, Belfast	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Mitchell, Thomas	West End, Truro	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pepper, John H.	Polytechnic Institution, Regent Street, London.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Philip, J.	Science and Art School, Oldham	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Robinson, Enoch	Dunkefield	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Wilson, Alexander	Barbury	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

TABLE showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the Examination of November 1895.

The asterisk before a Name indicates that the Teacher was Certified before the Minute of 2nd June 1899 came into operation.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical & Machine Drawing.	Building Construction & Naval Architecture.	Diemutary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Abbott, Joseph	Collegiate Institution, Liverpool	•	•	•	•	•	•	•	1	1	1	2	•	•	•	•	•	•	•	•	•	•	•	•
Adams, George	Newcastle-on-Tyne	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Adcock, Joseph H.	St. Mark's College, Chelsea	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Aldred, Edwin	Training College, Battersea	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Allen, Alfred H.	1, Surrey Street, Sheffield	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Allen, Leonard	Trinity House, Dundee	•	1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Allen, William	Grammar School, Monkton, near Spalding	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Allott, James	National School, Rnabon, North Wales	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Almgill, Thomas	3, Bexley Street, Salford	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Angell, John	Mechanics' Institute, Manchester	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Arthey, William	Wilde's Endowed School, Lowestoft	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Atkins, Edward	St. Martin's School, Leicester	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Atkins, George	Alberbury National School, near Shrewsbury	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bailey, Edward J.	St. Mark's College, Chelsea	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bain, Robert L.	Elizabeth Street, Maxwelltown, Dundee	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Baker, Bernard M.	Newport Pratt, County Mayo	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Baker, Richmond	Union Workhouse, Witham, Essex	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bald, John H.	84, Buccleuch Street, Glasgow	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Baldock, John H.	14, Claremont Place, North Brixton, London	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Bannister, Richard	7, Coulson Street, Chelsea, London	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Barklie, Robert	37, Ship Street, Belfast	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Barkus, William	1, Charing Cross, St. Helier's, Jersey	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Barret, E.	31, Gloucester St., Regent's Park, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Barter, William A.	Elacombe, Torquay	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bartley, George C. T.	Queen's Walk, Ealing	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beale, John H.	Science School, Banbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beatty, John	Endowed School, Oldcastle, County Meath	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beckett, T. W.	7, Clayton Street, Birkenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beer, James H. E.	Fore Street, Bodmin	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beechey, S.	St. Paul's School, Trammere, Birkenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beechey, Thomas	5, High Street, Banbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bennett, Alfred M.	Royal School of Naval Architecture, South Kensington	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bentley, Buzi	Kirkheaton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Berriman, John	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beveridge, Robert	2, Upper Kirkgate, Aberdeen	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bickerdike, William E.	Dalton Square, Lancaster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Birkenhead, E. H.	Mining School, Wigan	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bithell, Richard	Orphans' Home, Halifax	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Black, Robert	National School, Ballymena	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Blackwell, C. A.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Blay, Daniel	Portland British School, Riding-house Street, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bleas, William	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bocharoff, Alexis	17, Elton Street, Lower Broughton, Manchester.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Boddie, Adam	Wolverhampton, N. B.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bolan, James	Navigation School, Leith	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Clark, Albert Chas.	-
Clement, Leonard	-
Clough, James C.	-
Cockman, Abraham	-
Coles, Ferdinand	-
Collins, Frederick O.	-
Collins, John	-
Collins, Joseph H.	-
Conder, John	-
Constable, John	-
Cook, Charles L.	-
Cook, Thomas H.	-
Cooke, Mordecai C.	-
Coomber, Thomas	-
Cooper, Charles	-
Cooper, William	-
Cortin, Parnell G.	-
Cork, Charles S.	-
Cover, John L.	-
Cox, George E.	-
Crafts, Thomas	-
Craston, Thomas	-
Craven, Joseph	-
Crispin, John	-
Cribbins, Thomas	-

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Finlay, Alex. W. A.	53 India Place, Edinburgh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Forbes, Robert T.	Banton School, By Denny, N.B.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ford, Benjamin	Bolckow's Iron Works, Middlesboro'	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Foster, John S.	St. Mark's College, Chelsea, London	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Foster, Benjamin	Westeyan Training College, Horseferry Road	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Freehill, Michael	Model School, Trim	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fryar, Mark	Andersonian University, Glasgow	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fulton, Hugh	22 Brunswick Street, Euston Road	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galehouse, James W.	Training College, Battersea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gates, George	St. Mark's College, Chelsea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gayne, Arthur J.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gee, William	Union Street, Hyde, near Manchester	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gelschard, Charles	Walker Alkali Works, Newcastle	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gibbs, John	Baddow Road, Chelmsford	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gibson, George H.	Church Street, Ashby-de-la-Zouch	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gibson, Burford W.	6, Victoria Terrace, Rochester Square, Camden Town	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Giles, William B.	Chemical Laboratory, Royal Institute, Manchester	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gill, James		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gladhill, Joseph		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Goffin, Robert	Purleigh, near Maldon, Essex	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Goodwin, W. H.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grant, James	Hill Top, Burnley	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grant, William	Westeyan School, Selby	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Greenstreet, Wm. A.	Addlestone, Surrey	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Hudson, William	National School, Aberillery, near Newport	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hurst, Edwin	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hurst, Wm. F.	Knighton Street Schools, Leicester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hutton, David C.	Kirk Entry, Wellgate, Dundee	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hyslop, Lawrence	Albert Villas, Upper Grey Street, Edinburgh.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Isherwood, Thomas	Wesleyan Day School, Blackburn	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ives, William F.	St. John's School, Limehouse	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jackson, Robert	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jackson, William	Hunsingore School, Wetherby	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jarmain, George	East Parade, Huddersfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jeffery, Walter	Blue-coat Hospital, Gloucester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jeffer, William	5, Chesnut Place, Woolwich	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Johnston, William	The College, Chester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Alfred	8, Shakespeare Terrace, Stoke Newington	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Edward	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Eliz. S. L.	Yarmouth Navigation School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, James B.	Yarmouth Navigation School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, John	Rose Hill, Handsworth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, John	Copper Works School, Llanelli	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Richard	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Thomas	18, Dundas Terrace, Brookhill Road, Plumstead.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Jones, Thomas	68, Little Peter St., Gaythorn, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Judd, John W.	Wesleyan School, Hornsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Judd, William	High Street, Christchurch, Hants	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Mapp, George	National School, Redditch	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Marriott, John T.	British School, Andover	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Marshall, John E.	St. Thomas' Charterhouse	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Martin, William	Trafalgar, Salisbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mason, James	100, Upper Thames Street, E.C.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, David	Mechanics' Institute, Aberdeen	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, Elizabeth	50, Gloucester Street, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, John	50, Gloucester Street, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayne, Arthur J.	39, Upper Wellington Street, Dublin	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Meaden, Henry P.	5, George Street, Derby	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mellor, James	Science School, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Merrick, Edward	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Merrifield, John	Navigation School, Plymouth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Millard, George G.	South Kensington Museum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Millican, William	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mills, Joseph W.	Highfield, Greenhill, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mitchell, Thomas	Highfield, Greenhill, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moore, Thomas	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Morris, Mark	7, London Street, Liverpool	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Morton, George H.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moss, James	National School, Nilton, Isle of Wight	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moyse, John	National School, Nilton, Isle of Wight	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Muir, Robert	Auchinbreath	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Muldoon, Charles	North End National School, Larne	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson, Robert J.	Navigation School, Shadwell	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Redgrave, Gilbert E.	18, Hyde Park Gate South, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rich, Sidney W.	Hayes Lane, Esher	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Richardson, Henry	18, Dawson Street, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Richardson, Joseph	18, Dawson Street, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Richard, George J.	15, Duke Street, Devonport	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ricks, George	St. John's Town School, Portsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rigg, William	2, Oliver Terrace, Oliver St., Nottingham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ripley, Henry J.	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rivers, Albert	Burghfield, near Oakley	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Roberts, John V.	Gwenmuap, Redruth, Cornwall	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Robertson, John	Milton Established Church, Sessional School, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Robertson, John	Tagshott, Surrey	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Robinson, John	Warren Corner, Crondall, Hants	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Robotham, William	School of Mines, Bristol	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rosater, William	11, Greville Street, E.C.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rowden, William	Spring Grove, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rowland, Evan H.	National School, Llanferres, Mold	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Roberts, Leopold C.	Union Street, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rude, Charles H.	Training College, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Runde, James	Birkbeck Schools, Kingsland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rushforth, Thomas	Bluecoat School, Wolverhampton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rust, Joseph	21, Victoria Street, Maldenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ryan, Lawrence	Model School, Kilkenny	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Salmon, Wm. R.	Navigation School, Hull	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Salter, Edmund	Ashton-under-Lyme	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical & Marine Drawing.	Building Construction & Naval Architecture.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Ronomy.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Snell, Daniel - Snellus, George J. Sollas, William J.	St. Mark's College, Chelsea 22 Great Marylebone Street, London 27 Oakley Road, Southgate Road, Islington.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparkes, Arthur J.	National School, Albebury, near Shrewsbury.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Spear, John J.	Woodbine Cottage, Newtownirvey Road, Bray.	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Speers, Adam Spencer, James Spink, John Spriggs, Christopher	Holywood, County Down 17, New Street, Charles Town, Halifax Cathedral School, Ripon 10, Henry Street, Chorlton-on-Medlock, Manchester.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stanton, George	Berry Hill, Taplow, Maidenhead.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stead, Wilbraham Stevenson, James Stevenson, J. M'N. Stewart, John Stiles, James J.	The Grammar School, Lincoln New Public School, Kilmarnock Carrickfergus Magdalen Chemical Works, Musselborough Sunderland.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stirrup, Thomas Stockton, William	St. Mark's College, Chelsea 9, Montague Place, East India Road, London.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stone, William Stradman, Richard Stroud, Robert	Science School, Wolverton St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stibbe, Richard H. O. Sullivan, M.	St. Margaret's School, Westminster 3, Brecon Terrace, Moore Park, Fulham.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Wheatley, Alfred	Science School, Wolverton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wheeler, George H.	National School, Middleton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Whitehead, John E.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Whitehouse, Henry I.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
White, Edward	Eastington, Stonehouse, Gloucestershire	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wild, Robert	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wild, William L.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wilcock, Joseph	24, Market Place, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wiley, Thomas	30, Albion Grove West, Barnsbury, N.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Williams, John	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Williams, W. M.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Williamson, Stewart	33, Clifton Road East, St. John's Wood	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wilson, Thomas	62, Clarendon Street, Nottingham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Winney, William	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Winter, William	27, Ash Grove, Bradford, Yorkshire	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wire, Alfred P.	Prestbury Road, Macclesfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wood, Charles H.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wood, Edward	31, Richmond Place, Brighton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodcock, Ed. W.	The Grammar School, Bosworth, Hinckley	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodhead, William	23, Queen Street, Edgell, Liverpool	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodward, Chas. J.	Midland Institute, Birmingham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woollett, John	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wron, Edmond	Model School, Ballymena	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wynn, William T.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Yates, Frederick	Pennfields, Wolverhampton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(*Revised to April 1866.*)

14th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1866.

Price Sixpence.

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SCIENCE AND ART DEPARTMENT.
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CROMWELL ROAD, SOUTH KENSINGTON.

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*Vice-President of the Committee of Council on Education, The Right Hon.
H. A. BRUCE, M.P.*

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Instructor in Engineering Drawing.—John Maxton.
Instructor in Practical Chemistry.—John Davidson.
Instructor in French.—M. Penon.

SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.

*[Important Alterations made since the last edition of the Directory are
printed in Italics.]*

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department of which the Science and Art Department is a branch is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100*l.* a year. (See § xviii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and Teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given :—

- Subject 1, Practical Plane and Descriptive Geometry.
- „ 2, Mechanical and Machine Drawing.
- „ 3, Building Construction or Naval Architecture.
- „ 4, Elementary Mathematics.
- „ 5, Higher Mathematics.
- „ 6, Theoretical Mechanics.
- „ 7, Applied Mechanics.
- „ 8, Acoustics, Light, and Heat.
- „ 9, Magnetism and Electricity.
- „ 10, Inorganic Chemistry.
- „ 11, Organic Chemistry.
- „ 12, Geology.
- „ 13, Mineralogy.
- „ 14, Animal Physiology.
- „ 15, Zoology.
- „ 16, Vegetable Physiology and Economic Botany.
- „ 17, Systematic Botany.
- „ 18, Mining.
- „ 19, Metallurgy.
- „ 20, Navigation.
- „ 21, Nautical Astronomy.
- „ 22, Steam.
- „ 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to certificated teachers.
(See § xv., xviii., and xix.)

2. Grants towards the purchase of apparatus, &c.
(See § xxi.)
3. Public examinations in which Queen's Medals, Honorary Certificates, and Prizes are awarded, held at all places complying with certain conditions. (See § xi., xii., xiii., xiv., xv., xvi., and xvii.) On the results of these examinations the payments are made to the teachers. (See § xv. and xviii.)

VIII. Examinations for certificates to teach any of the before-mentioned sciences are held annually, commencing in the first week in November, at South Kensington. Examinations will also be held in Dublin, Edinburgh, and Manchester if five candidates register themselves for examination in Ireland and in Scotland and in the north of England. Any person whatever may attend this examination by sending in his or her name to the Secretary of the Science and Art Department, before the 15th October, stating the subject or subjects in which he or she wishes to be examined. Certificates of three grades are given in each subject. These certificates are only considered as simple records of the results of examination in the various sciences before mentioned, entitling the teacher to earn payments by successful teaching in the subjects for which he or she is certificated.* No payments can be made to a teacher on account of instruction in subjects in which he is not certificated.

Examinations
for Teacher's
Certificates.

IX. Suitable premises, with firing, lighting, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

School Pre-
mises.

* Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant.

Local Committee.

X. A Local Committee of not less than five well known responsible persons must be formed in connexion with every Science Class, who will carry out the instructions contained in Appendix. (See pages 14 and 18 to 22.)

Examination of Classes under Certificated Teachers.

XI. The Science and Art Department holds annually in May (see Science Form, No. 232, page 59), through the agency of the Local Committees, a public examination of all Science schools and classes in any locality throughout the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to certificated teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in mathematics, navigation, nautical astronomy, steam, and physical geography are held for the benefit of seafaring men, and for them only, three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of other Classes.

XII. A school or class taught by a teacher not holding a certificate, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under certificated teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21, Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of certificated teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 100 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether taught by the certificated teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and *fifth* class. The standard of attainment required may be raised from year to year. For the *fifth* class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited

Places of
Examination.

Examination
of other
Students.

Classification
of Results.

by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, except as below, *see a. and b.* (1) Students in Science Classes under Certificated Teachers; (2) Registered Students in Artisan Classes taught by Non-certificated Teachers, or (3) *bonâ fide* artisans.

Other candidates, if successful, receive instead Certificates of merit recording their success.

The following are exceptions to the above rule.

a. Science Certificated Teachers; and

b. Students who have previously received the same, or a higher class prize, in the same subject.

The names of such candidates will simply be recorded in the published lists.

Queen's
Medals.

XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (*see* § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the Payments to Teachers.
 certificated teacher on account of the instruction of students of the Artisan Classes (for definition of Artisan Class *see* Science Form No. 51, page 24) in the following manner:—

1l., 2l., 3l., 4l., 5l. are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced in the following ways:

1st. If the student has been successful in the same subject before such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4l. payment for a second class would, if the student had previously taken a fourth class, be reduced by 2l.*

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60l. the excess up to 40l. is diminished by one quarter, the excess above 40l. by one half. Thus payments which on the above scale would be 100l. and 150l. will be reduced to 90l. and 115l. respectively: †—provided that the student has received 25 lessons ‡ at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not neces-

* Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

† Thus, 100, that is $60+40$, is reduced to $60+40-\frac{1}{4}$ of 40 = $60+30=90$. 150, that is, $60+40+50$ is reduced to $60+30+25=115$.

‡ It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

sarily be all given in one year, but may extend over a longer period.

Form of Claim
for Payment.

XIX. The claim of a master for the payments under these several heads is made on Science Form No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the committee of the science class or school; or by at least three of the committee. (See Appendix, page 24.)

School
Register.

XX. A school register must be kept in each subject on a form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for
Apparatus.

XXI. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to science schools and classes in Mechanics' and similar institutions where the teacher is certificated, and to the extent of 5*l.* to other poor schools and classes. A requisition must in these cases be made on Science Form, No. 49. (See page 30.)

Travelling
Expenses of
Teachers.

XXII. The travelling expenses (second-class railway fare, and 10*s.* per diem personal allowance) of a candidate in attending the November examination are paid if he be successful in taking a certificate or in improving the grade of one he has already taken, provided the candidate is bonâ fide engaged in tuition, or is preparing for tuition.

Instruction in
an Elementary
School.

XXIII. All payments to certificated teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect

of any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

XXIV. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

Use of
Elementary
School
Premises.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.

Before 30th November.	Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.
Constantly - - -	To visit the School and see that the Register is kept from day to day, and that everything is regular.
Before 1st January	To carefully fill in and send to the Department Form No. 120.
Before 31st March	To send Form No. 119 applying for examination in May.
Before 24th April -	To see that Form No. 91 is hung up in the School-room.
On the 27th April	If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate <i>at once</i> to the Department.
During the May examinations.	The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent <i>at once</i> to the Department.
On the evening of examination.	The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.
After the May examinations.	On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed. To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 123. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108. To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50*l.* per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1866 examination two of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grade Queen's Prize, in any subject	-	-	9 marks.
To a 2nd " " "	-	-	7 "
To a 3rd " " "	-	-	5 "
To a 4th " " "	-	-	3 "
To a 5th " " "	-	-	1 "

and in addition—

For a gold medal	-	-	10 "
For a silver medal	-	-	7 "
For a bronze medal	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

EXHIBITIONS AND FREE ADMISSIONS AT THE GOVERNMENT SCHOOL OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are ten Royal Exhibitions to the Government School of Science, Dublin, of the value of 50*l.* per annum, entitling the holders to free admission to all the lectures and the chemical and metallurgical laboratories at the Government School of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the school.

At the May 1866 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, *etc.* offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz. :—

To a 1st grade Queen's Prize, in any subject, 9 marks.			
To a 2nd	"	"	7 "
To a 3rd	"	"	5 "
To a 4th	"	"	3 "
To a 5th	"	"	1 "
and in addition—			
For a gold medal,	"	10	"
For a silver medal	"	7	"
For a bronze medal,	"	5	"

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Government School of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

FORM of APPLICATION for the ROYAL EXHIBITIONS to the ROYAL SCHOOL OF MINES, Jermyn Street, London, and the GOVERNMENT SCHOOL OF SCIENCE, Dublin.

The following candidates at the recent May Examinations are candidates for the Royal Exhibitions at the* _____

and they are either—

1. Under 21 years of age.
 2. Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
 3. Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
 - a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
 - b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
 - c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
 4. That they are entitled to be considered as a special case on the following grounds :—
- _____
- _____

We hereby certify that the above particulars are correct.

 _____ { *Chairman or Secretary.†*
 _____ { *Two members of the*
 _____ { *Committee.†*

* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.

† Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full,

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS
AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.

- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artisans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.

5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- [f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher have any pupils for examination, or be a pupil himself.
- g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Head of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
- h. It is absolutely necessary that at least two such responsible persons should agree to act.
- i. The Committee must consist of a Chairman, Secretary, and at least three other Members.
- k. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
- l. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
- m. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1*l.* annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1*l.* in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
- n. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by _____

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
_____ <i>Chairman.</i>		
_____ <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules 1, 2, 3, 4, and 5.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

To be made on its establishment, and annually (before the 1st January) of its continuation.

Name of Town _____

Place, as Mechanics' Institution, &c., in which the Classes are held _____

Name of Street, No., &c. _____

Name of Teacher or Teachers _____

Their private addresses

Total No. of individual Students _____

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.
					71

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for *new* members to *sign* the form undertaking to perform the various duties.)

SCIENCE FORM, No. 129.
APPLICATION FROM **SCIENCE SCHOOL FOR EXAMINATION IN MAY.**

To be sent to the Secretary of the Science and Art Department before the end of March.

Number of students under instruction during the year } Number intending to present themselves for examination } Number intending to present themselves for examination not belonging to the class }	I.	Practical, Plane, and Descriptive Geometry.	II.	Mechanical and Machine Drawing.	III.	Building Construction.	IV.	Elementary Mathematics.	V.	Higher Mathematics.	VI.	Theoretical Mechanics.	VII.	Applied Mechanics.	VIII.	Acoustics, Light, and Heat.	IX.	Magnetism and Electricity.	X.	Inorganic Chemistry.	XI.	Organic Chemistry.	XII.	Geology.	XIII.	Mineralogy.	XIV.	Animal Physiology.	XV.	Zoology.	XVI.	Vegetable Physiology and Economic Botany.	XVII.	Systematic Botany.	XVIII.	Mining.	XIX.	Metallurgy.	XX.	General Navigation.	XXI.	Nautical Astronomy.	XXII.	Steam.	XXIII.	Physical Geography.
---	----	---	-----	---------------------------------	------	------------------------	-----	-------------------------	----	---------------------	-----	------------------------	------	--------------------	-------	-----------------------------	-----	----------------------------	----	----------------------	-----	--------------------	------	----------	-------	-------------	------	--------------------	-----	----------	------	---	-------	--------------------	--------	---------	------	-------------	-----	---------------------	------	---------------------	-------	--------	--------	---------------------

Total number of students * under instruction during the year

Total number of students * intending to present themselves for examination

Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

FORM No. 363.

The following form, which may be had on application to the Secretary, Science and Art Department, is filled up in italics as an example of the manner in which it should be done.

AN ACCOUNT OF TRAVELLING AND PERSONAL EXPENSES DISBURSED AND CHARGED BY

Thomas Jones,

From the *2nd November 1860*, to the *4th November 1860*.

I hereby certify that the travelling expenses detailed below have been actually disbursed by me in travelling in the execution of my public duties, that the personal expenses are charged according to the regulations, and that the total sum of £1 13s. 8d. is due to me for the services stated.

Thomas Jones,

[Name and title of officer to be specified.]

Teacher of Chemistry in———School of Brighton.

Date upon which the services were Performed.	In this column must be stated the service on account of which the journeys were performed, and the details of the expenses incurred.	TOTAL AMOUNT.
<i>1860.</i>	<i>To attend examination in Chemistry held at South Kensington on 3rd November 1860.</i>	
<i>2nd November.</i>	<i>Railway fare from Brighton to London (2nd Class) - - - - - 0 6 6</i>	
<i>3rd November.</i>	<i>Omnibus fare to and from Charing Cross and South Kensington - - - - - 0 0 8</i>	
<i>4th November.</i>	<i>Railway fare from London to Brighton - - - - - 0 6 6</i>	
	<i>3 days' personal allowance at 10s. - - - - -</i>	<i>0 13 8</i>
		<i>1 0 0</i>
		<i>1 13 8</i>

NOTE.—Should the successful candidate live in London, Edinburgh, &c. or near enough to get home at night, he is only to be allowed ss. per diem besides his travelling expenses.

Examined and approved,

Secretary.

Received this _____ day of _____ 18 _____, the sum of

_____ pounds _____ shillings and _____ pence, in pay-

ment of the above amount.

£ _____

SCIENCE FORM No. 51.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from _____ Science Teacher in _____
School or Institution at _____ for payment.

On behalf of the Committee of Management of this School, We do hereby certify :—

- (1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .
- (2). That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (3). That the under-mentioned students are *artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.*

_____ } Two mem-
 } bers of
 } Committee.

I hereby certify that the following particulars are correct.

_____ **Teacher.**

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deductions.

[illegible]

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour, the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

[SPECIMEN.]

Science Form, No. 51.
South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from *John Smith*, Science Teacher in the *Science School*
or Institution at *Midhurst* for payment.

On behalf of the Committee of Management of this School, We do
hereby certify:—

- (1.) That *Mr. J. Smith* has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of May 1865;
- (2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;
- (3.) That the undermentioned students are *artizans or operatives** in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, { Two mem-
James Robinson, { bers of
Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Position in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade		
<i>Adams</i> ,	<i>James</i> ,	22	<i>Carpenter</i> ,	<i>X.</i>	<i>1st</i>	—	£ s.
"	"	"	"	<i>XI.</i>	<i>2nd</i>	<i>4th</i>	5 0
<i>Barber</i> ,	<i>John Wm. Henry.</i>	14	<i>Butcher (f)</i>	<i>XIV.</i>	<i>Pass</i>	—	1 0
				<i>X.</i>	<i>1st</i>	<i>2nd</i>	0 10
<i>Smith</i> ,	<i>William</i> ,	12	<i>Baker (f)</i>	<i>XI.</i>	<i>4th</i>	—	2 0
				<i>I.</i>	<i>1st</i>	—	5 0

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _____ Secretary of the Local
Committee for the Science School or Class at _____
for payment of allowance for duties connected with the School, and for
superintending the examination.

Sir,

Being entitled to payment according to the regulations of the
Science "Directory,*" for duties connected with the Science Class at
_____ and for superintending the arrangements
for carrying out the examinations on _____ the following days
in May 186 , I request that the sum of £ _____ may
be paid to me, being the authorized fee.

Dates of Examination.

Dates of Examination.

Dates of Examination.

I am, Sir,

Your obedient Servant,

The Secretary,

Science and Art Department.

**CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS,
&c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES
(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),† IN
PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.**

1. The Lords of the Committee of Council on Education, having had
under their consideration several applications from the managers and
masters of Mechanics' and other Institutions, for grants to be made to
them of Apparatus and Illustrations, recommended by the Science and
Art Department for teaching science, think it necessary to adopt some
general principle which shall regulate the decisions of the Committee in
reference to such applications.

* £1 annually for furnishing the returns, &c. specified on Science Form No. 170, con-
nected with any Science school or class, and £1 in addition for each day's examination
held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10*l*. in value may be obtained by poor Schools and Me-
chanics' Institutes, not taught by a certificated teacher, under the same conditions,
that is, the Department will aid them to the extent of 5*l*.

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

"1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

"2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

"3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c.; or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

No. 1 application to be filled in by Requisitionist, with full particulars.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

Having
(*) Erase the words that do not apply.

	Male	Female
and		

(*) Pupils (Artisans or Operatives) of the Science Class.

(*) Scholars or Members of Poor School or Mechanics Institute.

Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____
per _____ at _____

Dated this _____ day of _____ 186 .
Signature of Requisitionist.

No. 2 to be filled in by the Department.

2. Requisition sent to M _____ Agent,
this _____ day of _____ 186
and authority given for the supply of Articles to the extent of _____
Net Sum

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

No. 3 to be filled in by agent on transmission of the invoice.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186
Articles (Retail Price) £
Deduct as above,—
Aid by Department
Add, for packing
Total to be paid by Requisitionist

Nos. 4 and 5 to be filled in by agent.

4. Amount £ _____ received from schools this _____ day of _____ 186 .
Agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 .
Agent.

No. 6 to be filled in by Requisitionist.

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 .
Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91,

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

* 3. All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day before that fixed for the examination.

* 7. The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

* 8. The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

* 9. When the candidates are seated and the papers given out, the Committee will see that the candidates *commence* by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

* 10. Candidates must on no account bring anything with them into the examination room,‡ except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed.§ Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

* 11. Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

† When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, *i.e.*, pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. But nothing must be torn off the form.

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

* 13. The examination papers being given out no candidate must be allowed to return after having once left the room.‡ On a candidate leaving the room his papers must be taken up.

* 14. At 10 p.m., precisely, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c., it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

* 15. Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with to the letter. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures.	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

† Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

‡ It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

SYLLABUS OF THE SUBJECTS IN WHICH CERTIFICATES AS TEACHERS OF SCIENCE ARE GIVEN BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates for certificates as teachers of Science, some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to, and satisfactory evidence may be required of the teacher's power of giving information to a class. The groups are divided as shown, the examination in each subject being distinct, so that candidates may, if they desire it, take a certificate only in one subject of a group. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

Any certificate obtained at the examination may be raised, by re-examination, in the next or any following November to a higher grade.

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Group I.	- Geometrical Drawing, &c.	Prof. T. Bradley.
" II.	- Mechanical Physics	- Rev. B. M. Cowie, M.A.
" III.	- Experimental Physics	- Prof. Tyndall, F.R.S.
" IV.	- Chemistry	- Prof. Hofmann, F.R.S.
" V.	- Geology	- Prof. Ramsay, F.R.S.
"	Mineralogy, &c.	- Prof. W. W. Smyth, M.A., F.R.S.
" VI.	- Zoology	- Prof. Huxley, F.R.S.
" VII.	- Botany	- Edwin Lankester, M.D., F.R.S.
	Navigation and Nautical Astronomy.	J. Riddle, F.R.A.S.
	Physical Geography	- Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published :—

Lecture I.	- Vegetable Physiology and Economic Botany.	Edwin Lankester, M.D., F.R.S.	3rd February.
Lecture II.	- Mechanical Physics	Rev. B. M. Cowie, B.D.	10th February.
Lecture IV.	- Mining	W. W. Smyth, M.A., F.R.S.	24th February.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is certificated in I.

Subject I.—Practical Plane, and Descriptive Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is expected to have acquired readiness in the use of the usual drawing instruments and materials, to be skillful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of all objects of construction, which are universally symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* and the *vernier* subdivision. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses, and of the pentagraph and eidograph, in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.
6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 \pm b^2}$, &c.

7. To construct a triangle, any three parts being given.

Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the trigonometry method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

For the preceding part of the course, a fair knowledge of the first six books of Euclid is strongly enjoined, some acquaintance also with trigonometry will be of service, as without such previous knowledge, the learner is simply copying what is set before him, and cannot attain the highest skill in drawing.

Constructions in Solid Geometry.

(Descriptive Geometry.)

Preceded by explanations of the term *projection*, and of the necessity for it, in order to express graphically, on a surface, *solids* of any kind; the distinction between *orthographic* and *perspective projections*; their uses, and general principles which are the foundation of their practical application.

Orthographic Projection.

Why the projections, of any solid consisting of a combination of geometric forms, on two or three *co-ordinate planes* are necessary to show the form and dimensions of that solid.

Meaning of the terms *plan*, *elevation*, *profile*, *section*. The principle of the representation of *surfaces* by the projections of their generators, or of equi-distant horizontal sections termed *contours*. The direction and inclination of an indefinitely extended plane given by its contours, or by its *traces* on any two co-ordinate planes.

These principles should be quite familiar to the candidate, and will be tested by making him draw plans, elevations, and sections of simple solids, as prisms, pyramids, cones, spheres, cylinders, and of symmetrical solids formed by their combinations.

A few of the problems relating to points, lines, planes, and curved surfaces, will be required, as—

1. To draw lines and planes parallel or perpendicular to each other, to contain given points or lines, and the limits of the possibility of solution of any problem should always be understood.
2. The preceding constructions combined and applied to determine by their projections the simple solids before mentioned, when they are not symmetrically situated with respect to the supposed planes of projection.

3. Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., would all be benefited by a knowledge of it.

This application has been termed Stereotomy, and better and more significantly in French, "Coupe de pierres."

Much practical knowledge of the subject, arising from their pursuits, is possessed by workmen, while the want of a scientific knowledge of it compels architects, engineers, and their drawing clerks to leave to the workmen the execution of their conceptions which they cannot themselves design.

4. The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection.

Is usefully employed in the representation of works chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is much increasing: it is readily understood, and can be practised by anyone who has gone through the first two articles of this section.

Perspective Projection.

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.), and an acquaintance with the leading properties of the conic sections, the geometry of the sphere, and some spherical trigonometry is important, it cannot be too urgently recommended to all persons wishing to master this course, to study such works as "Geometry, Plane, Solid, and Spherical" of the Library of Useful Knowledge, and Mr. Bell's, in Chambers' Educational Course.

Geometry, Plain, Solid, and Spherical (Library of Useful Knowledge) is especially recommended as a work to be studied on Theoretical Geometry. Text-Books for Practical Plane Geometry.—Bradley's *Geometrical Drawing*; Burchett's *Practical Geometry*; *Practical Geometry, Linear Perspective and Projection* (Library of Useful Knowledge).

For Descriptive Geometry.—Bradley's *Geometrical Drawing*; Hall's *Elements of Descriptive Geometry for Students in Engineering*.—Heather's *Descriptive Geometry*. Also the following French Works, which are mentioned in consequence of the great deficiency of English Works on Geometrical Drawing.—*Eléments de Géométrie Descriptive*, par S. F. Lacroix; *Traité de Géométrie Descriptive*, par Levebure de Fourcy;

Nouveau Cours raisonné de Dessin Industriel, par Armengaud, aîné, et Armengaud, jeune, et Amouroux; Bardin's Works on Descriptive Geometry.

Subject II.—Mechanical and Machine Drawing.

The candidates in Subjects II. and III. will, some time before the examination, have specifications of subjects given to them, of which they will be required to prepare drawings before the examination. These drawings must be bonâ fide their own. The candidates may be examined on them, and if the results be satisfactory, they will count towards their certificates, but they will only be taken into consideration when it is clearly seen from the regular examination that the candidate is qualified for a certificate.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood; iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. *Arithmetic generally.*
2. *Geometry.*—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.
3. *Algebra.*—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple

equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.

4. *Plane Trigonometry*.—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and *vice versa*. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90° , 45° , 60° , 30° , 180° , 120° , 150° , &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulae for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, $2A$, $3A$, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in terms of $\frac{A+B}{2}$ and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulae for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:—

- (1.) Geometry. The first book of Euclid.
- (2.) Algebra, to simple equations and problems (inclusive).
- (3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class:—

- (1.) Geometry. The first three books of Euclid.
- (2.) Algebra, to quadratic equations.
- (3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

1. *Algebra*.—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.
2. *Plane Trigonometry*.—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.
- Spherical Trigonometry*.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by

impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates ; locks ; water-wheels ; turbines ; water-pressure engines ; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended:—Willis's *Mechanism* ; Baker's *Elements of Mechanism* ; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics* ; Goodeve's *Elements of Mechanism*.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated ; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds ; of pitch ; of harmony and discord ; to commit to memory the rates of vibration of the several notes of the gamut ; to be able to make sonorous vibrations visible by means of glass plates and membranes ; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light ; to be able to state the laws of both ; to explain what is meant by total reflection ; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it ; why a stick appears bent when dipped obliquely into water ; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex ; to describe the characters of their images, whether erect or inverted ; magnified or reduced ; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Subject IX.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—This candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Combining weights and chemical equivalents. Combining volumes. Chemical symbols and their use in the explanation of chemical changes. The atomic theory.

The non-metallic elements: *Oxygen*. Combustion.

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Nitrogen. Nitrous oxide, nitric oxide. Nitric acid. Nitrification. Ammonia.

Carbon. Process of carbonization. Carbonic oxide. Carbonic acid. Marsh gas. Olefiant gas. Manufacture of coal gas.

Sulphur. Sulphurous acid, sulphuric acid. Sulphuretted hydrogen. Bisulphide of carbon.

Chlorine. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Bromic acid and hydrobromic acid.

Iodine. Iodic acid, periodic acid, and hydriodic acid.

Fluorine. Hydrofluoric acid.

Phosphorus. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Phosphoretted hydrogen. Chlorides of phosphorus. Manufacture of matches.

Boron and boracic acid.

Silicium and silicic acid.

The metals: *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of carbonate of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese. *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. *Nickel*. *Chromium*. *Zinc*. *Cadmium*. *Copper*. *Lead*. Manufacture of white lead.

Bismuth. *Mercury*. *Tin*. *Arsenic*. Course of analysis in cases of poisoning.

Antimony. *Silver*. *Gold*, and *platinum*. Their principal compounds with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Iron spoon.	Platinum wire and foil.
Metal filter stand.	Tongs.	Funnels.
Wash bottle containing distilled water.	Pestle and mortar.	Cut filters.
Spirit lamp.	Porcelain dishes.	Sulphuretted hydrogen apparatus.
Black blowpipe.	Watch glasses.	Platinum crucible.
Charcoal for blowpipe experiments.	Porcelain crucible.	Hera path's blowpipe.
	Triangles.	Stirring rods.
	Test tube cleaner.	

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Phosphate of sodium.	Acetic acid.
Hydrochloric acid.	Chloride of barium.	Hydrofluosilicic acid.
Nitric acid.	Chloride of calcium.	Oxalate of ammonium.
Hydrosulphuric acid.	Lime water.	Acetate of lead.
Potassa.	Sulphate of calcium.	Sesquichloride of iron.
Ammonia.	Sulphate of potassium.	Ferrocyanide of potassium.
Chloride of ammonium.	Sulphate of magnesium.	Chloride of platinum.
Sulphide of ammonium.	Chromate of potassium.	Nitrate of silver.
Carbonate of ammonium.	Oxalic acid.	
	Tartaric acid.	

In the solid state.

Carbonate of sodium.	Borax.	Blue and red litmus paper.
Nitrate of potassium.	Lime.	
Cyanide of potassium.	Sulphate of iron.	

Subject XI.—Organic Chemistry.

Ultimate analysis of organic bodies. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the equivalents of organic acids and bases, examination of products of decomposition, determination of the vapour-density of volatile bodies. Law of substitution.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Ammonia and its derivatives. Amides and amines : their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books. — Graham's *Elements of Chemistry*, Miller's *System of Chemistry*, Fownes' *Manual of Chemistry*, Gregory's *Outlines of Chemistry*, Abel and Bloxam's *Handbook of Chemistry*, Galloway's *Qualitative Analysis*.

Subject XII. —Geology.

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks,—marine strata—delta formations—freshwater beds,—the sign by which you can distinguish these.
3. The mode of occurrence of igneous rocks, ashes, lavas, and dykes.
4. Volcanoes and volcanic phenomena.
5. The theory of central heat.
6. Elevation and depression of land.
7. The ordinary mineral substances that enter into the composition of rocks.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks.

British Strata.

1. Description of the Cambrian strata and Silurian strata, their lithological characters, disturbances and chief fossils.
2. Description of the old red sandstone and Devonian rocks, character and fossils. Origin of cleavage. Slate and slate quarries, building-stones, limestones, and marbles.
3. The carboniferous limestone and coal measures. Character, fossils, and mode of formation. Origin of the coal of the coal-measures, and its mode of occurrence. Mode of occurrence of the ironstone of the coal measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Lime quarries, marbles, and building stones. Clay pits and potteries of the carboniferous strata. Fire clay. Alum shale.
4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones.
5. The new red sandstone (or 'Trias), its subdivisions, fossils, building-stones, sand pits, rock salt, and brine springs.
6. The Lias. Its subdivisions, chief fossils, building-stones, and other hydraulic limestones, and clay pits.
7. Oolitic rocks. Subdivisions, leading fossils, building-stones. Limestones. Clay pits, and other economic products.
8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clay pits.
9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stone of lower greensand. Gault, its phosphatic nodules and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints.
10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
11. Crag. Its subdivisions, chief fossils, phosphatic remains.
12. Disturbance and denudation of strata.
13. Unconformities, faults, and fractures.
14. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
15. Water-bearing strata, and underground drainage. Artesian and other wells.
16. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds or lodes.
17. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

18. The occurrence of stream tin, gold, &c., in superficial detritus.
 19. The chief differences in the nature and mode of occurrence of various formations in areas widely separated from each other.
- Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*.

Subject XIII.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.
- E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.
- G. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London, 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the

practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood *on the Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

The field presented by Natural History is such an exceedingly wide one, that candidates are advised to confine their studies to the subjects enumerated below, and to master these as thoroughly as possible. And as in the Natural Sciences, the knowledge which is obtainable by mere reading is of very little value, candidates are particularly recommended to study nature for themselves, and to become personally acquainted with the primary facts of Biological Science. Thus in Physiology, the fundamental truths relating to circulation, muscular contraction, and nervous action, may all be readily exemplified by simple experiments upon the common frog; and in Systematic Zoology and Botany, the careful study of the structure of the animal and vegetable forms enumerated under the head of "types" will furnish a better conception of the animal and vegetable worlds than any amount of mere reading. Candidates will therefore be expected to be thoroughly and practically acquainted with the fundamental facts of Physiology, and in Zoology, with all the most important and distinctive characteristics of such of these typical genera as are illustrated by British species.

Candidates should have carefully studied what is stated upon the subjects enumerated below in any good handbook of Physiology.

The general properties of living matter in respect of form, structure, and chemical composition. The meaning of the terms organ, organization, function, development. The difference between high and low organization. The division of physiological labour.

Why the living organism wastes. The difference between vital and putrefactive decomposition. The conditions and ultimate products of vital decomposition. The living body considered as a machine performing a certain amount of work.

Why food is necessary. The difference between the food of plants and that of animals. The nature of the substances which constitute the food of man. The proximate chemical composition of milk, flour, meat, butter, potatoes, oatmeal, peas, rice, tea, coffee, beer, wine, and spirits; and the distinction of the proximate elements of each into nutritious and innutritious.

Why digestion is necessary, and how that function is performed in the human organism. The structure of the organs by which the following substances are formed, and their uses: saliva, gastric juice, pancreatic juice, bile. How the nutritious products of digestion are separated from the excrementitious residuum. The process of absorption. The means by which absorbed matters are conveyed to all parts of the organism. The structure and composition of human blood. The course and mechanism of the circulation.

Why the elimination of waste products is necessary. Excretion of carbonic acid. The mechanical and physical principles involved in the performance of the respiratory process in man. The excretion of urea and uric acid. The structure of the urinary apparatus, and the mechanical and physical principles involved in its action. The excretion of water as a part of the foregoing processes, and as effected by the skin. The structure and other functions of the skin. The mutual relations of the three great excretory apparatuses.

The conditions and sources of animal heat. The circulatory system of man viewed as a hot-water warming apparatus. The fuel of the animal economy and its sources.

Animal mechanics. The human body as a locomotive apparatus. The structure of bones and joints. The structure and properties of muscle.

The structure and functions of nervous matter. The offices of the spinal cord and brain. The nature and mode of action of the sensory organs. Reflex action. Habit, as acquired reflex action. Instinct. Intellectual and emotional operations.

The nature of death, and the difference between general and local death.

Local death :—1st, as a part of life; *e.g.* moulting, shedding of skin and teeth. 2nd, as opposed to life; *e.g.* sloughing and mortification.

General death :—1st, as the natural conclusion of life. 2nd, as arising from disease or injury. Usual commencement of death in the nervous centres, the heart or the lungs.

Reparative processes :—1st. Local, as exhibited in the reproduction of lost parts, healing of wounds, &c. 2nd. General, as shown in the reproduction of the individual by sexual generation. The origin and development of the embryo. The nutrition of the fœtus and of the infant. Hereditary transmission, and the modification of physical and mental characters by education, as the basis of a rational belief in the possibility of human progress.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms, classes, and orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be able to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia, Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—*Hydra, Sertularia, Plumularia, Actinia, Corallium, Fungia, Oculina*.

iii. Starfishes, sea urchins, and *Holothurie*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster, Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lumbricus, Hirudo, Distoma, Tania, Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme

metamorphosis. The water flea as exemplifying a sexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Libellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells" (*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads. Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodilus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implacental mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hibernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*,

Cervus, Bos, Ovis, Felis, Phoca, Phocæna, Dasyplus, Hulmaturus, Ornithorhynchus.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Physiology.—Carpenter's *Animal Physiology*, Bohn, 1859; Dr. Kirke's *Manual*; Andrew Combe's *Physiology applied to Health and Education*. For Zoology.—Dallas's *Natural History of Animals*; Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Green's *Manual of the Protozoa*.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.
11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafoetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Réveille and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanthus, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Algae*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceae*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceae*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceae*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceae*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceae*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceae*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceae*. The nettle and hop tribe. Its relations to *Moraceae*, *Artocarpaceae*, *Cannabinaceae*, and *Ulmaceae*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceae*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*.
16. *Polygonaceae*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
17. *Primulaceae*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
18. *Labiatae*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
19. *Scrophulariaceae*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
20. *Boraginaceae*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
21. *Solanaceae*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.

22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellatæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Gakum*, *Rubia*.
 25. *Umbellifereæ*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Athusa*, *Eranthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Crucifereæ*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alliaria*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for; description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different

classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's *Report on Cornwall and Devon*. Greenwell's *Treatise on Mine-Engineering*. Dunn on the *Winning and Working of Collieries*. Hedley on *Colliery Working and Ventilation*. Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines*. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.**I. Introduction.**

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast, and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes; treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of saffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. **Elementary Principles.**—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale. Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

NOTE.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," as far as principles of plane sailing. The compass and correction of courses.

For honourable mention.—As far as Mercator's sailing, with examples.

For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon *below* the pole and by pole star. Latitude by altitude of sun or other heavenly body *near* the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

OBS.—In all the above problems the demonstration of the rules as well as *accurate* practical working is required.

NOTE.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To "pass," a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

1. *General Properties of Steam.*—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent

heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.

2. *Steam Engine.*—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish—High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser gauge. Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors. Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
3. *Boilers.*—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.
4. *Calculations.*—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the

- crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.
5. *Practical working*.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.
 6. *Indicator*.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.
- Dynamometer. To find horse-power of engine by means of it.
- The text books specially recommended are—*The Marine Steam Engine*, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's *Indicator and Dynamometer*; De Pambour's *Theory of the Steam Engine*.

NOTE.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII.—Physical Geography.

The knowledge included in this subject embraces:—

- a. A general acquaintance with astronomy, so far as it relates to terrestrial phenomena.
- b. Distribution of the land and water; forms of the great continents; the general structure of land with regard to mountains, table lands, plains, deserts, islands, &c.
- c. The ocean; its physical and chemical characters, temperature, depth, waves, tides, tidal bore, progress of the tide wave, ocean currents, and soundings.
- d. Inland waters, including the phenomena of springs, rivers, lakes, and influence of the distribution of inland waters upon commerce.
- e. Winds, including land and sea breezes, trade winds, variable winds, law of storms, cyclones, &c.
- f. Climate: physical causes which determine climate, isothermal lines, and temperature tables.
- g. Distribution of plants and animals, especially as their produce is turned into articles of commerce; and classification of the races of man.
- h. Information on the physical geography of the British and Colonial Empire of Great Britain, with especial reference to exports and imports.

SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS
AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May :—

1. That there shall be two examination papers in each subject ; one of which (the first) will be an easy paper, the other (the second) more difficult.

2. That the candidate shall be allowed to select questions out of either the first or the second paper ; but not out of both.

3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.

4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only ; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80* marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.

* These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS and CLASSES, showing the NUMBER of STUDENTS under INSTRUCTION in 1865-66, and NUMBER of MEDALS and PRIZES obtained.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1864-5.	1865-6.			1864.	1865.	1864.	1865.
ENGLAND.												
Accrington	Mechanics' Institution	Ingram, J.	Ratcliffe, Wm.	Gunn, W.	21	21	..	..	..	..	..	..
Alderley Edge	Day School Room	Consterline, Rev. J. W.	Railton, G. W.	{ Slater, James K. Jones, Thomas }	..	20	..	..	..	..	..	..
Almondbury	King James' Grammar School.	Dyson, Edward	Jones, Rev. Lewis	Jarmain, George	12	16	4	..	5	1	..	..
Andover	Mechanics' Institution	Bracker, Henry F.	Footner, Richd.	Marrlott, J. T.	16	34	18	..	..	2	..	..
Ardrwick	Chancery Lane Educational Institution.	Mayson, J. S.	Lawton, Thomas	Butterworth, Thos.	..	8	8	..	..	..	..	..
Ashby-de-la-Zouch	Mutual Improvement Society's Rooms.	Smith, H. E.	Dalby, John	Gibson, George H.	..	34	34	..	..	..	..	..
Ashton-under-Lyne	Mechanics' Institution	Mason, Hugh	Howorth, D. F.	Butterworth, Thos.	..	16	16	..	..	..	..	..
Bacup	Mechanics' Institution	Aitken, Thos.	Newbigging, T.	Shore, Thomas W.	27	38	11	..	11	9	..	..
Banbury	British School Academy	Harlock, John	Cadbury, James	Beale, J. H.	..	20	20	..	..	..	..	..
"	"	Harlock, John	Cadbury, James	Wilson, Alexander	..	8	8	..	..	..	..	..
Birmingham	Midland Institute	Martineau, T.	Smith, Edwin	Woodward, C. J.	93	87	6	..	16	19	{ 1 G., 1 S., 1 B. }	..
Blackburn	Mechanics' Institution	Thompson, James	Hand, Thomas	Gunn, William	..	15	15	..	..	4	..	..
Bodmin	Literary Institution	Collins, C. M. E.	Phillips, Josias	Downing, Sampson	..	20	20	..	..	..	..	..
Bolton	Bridge Street School	Cannon, W. W.	Marsden, Peter C.	Ward, Thomas	..	50	50	..	..	..	..	..
"	Mechanics' Institution	Hick, John	Lowe, Rev. J.	{ Mellor, James Spriggs, C. Collins, J. }	55	89	34	..	16	14	..	1 B.
"	Independent Methodists' School.	Winterburn, Geo.	Vickers, James	Collins, John	..	34	34	..	..	..	..	..
"	Holy Trinity Working Men's Institution.	Hick, John	Lowe, Rev. J.	Collins, J.	54	24	30	..	12	10	..	..
Bristol	Diocesan Trade School	The Rev. Canon Moseley.	Wilkinson, John	{ Coomber, Thomas Leipner, A. Plant, E. C. }	120	120	..	..	31	97	..	{ 4 G., 2 S., 4 B. }
Burnley	Church of England Literary Institute.	Parker, A. Townley	Briggs, Benjamin W.	{ Shore, T. W. Gunn, W. Pickup, W. }	37	70	33	..	9	13	..	1 G
"	Fulledge Wesleyan School	Butterworth, John-Thomas.	Butterworth, Thomas.	{ Healey, Thomas }	..	19	19	..	..	..	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1864-5.	1865-6.			1864.	1865.	1864.	1865.
Kilner	National Schoolroom	Wharton, George	Bolton, Thomas.	Packer, M. W.	24	28	..	2	11	3	..	..
Leeds	Mechanics' Institution	Oxley, Henry	Blaker, Barnett	Ward, George	40	33	..	7	31	10	..	..
Leicester	St. Martin's School and Ashwell Street School.	Vaughan, Rev. D. J.	Jones, H. S.	Atkins, Edward	..	34	34	..	6	6	..	..
Liverpool	Free Library	Samuelson, James	Gregson, S. Leigh	Birkenhead, E. H.	37	28	..	9	20	13	3 B.	1 G.
Llanelli	Copper Works School	Nevill, C. W.	Davies, John	Jones, John	..	31	31	..	..	..	..	..
London	Birkbeck Schools	Tidcombe, Rev	Rhutz, George	Pike, Robert W.	95	109	14	..	14	6	..	..
Bethnal Green	St. Matthew's School	George H.	Hallday, J.	Simpson, B.	30	31	1	..	2	2	..	..
Camden Town	Camden Hall	Litchfield, R. B.	Waterman, O.	Snelus, George J.	..	38	38	..	..	6	..	..
Gt. Ormond Street	Working Men's Institution	Godding, Rev. J.	Goelin, John	Crowe, William	..	24	24	..	1	1	..	..
Homerton	Parochial School	Fleming, Rev. W.	Rosa, John	Howard, John	95	113	17	..	13	15	1 G.	1 G., 1 S., 1 B.
Islington	Lower Public School	Aveling, Thos.	Hoskins, W. H.	{ Tate, Ralph Bithell, Richard. Gregson, A. Snelus, G. J. Coles, F. }	75	70	..	5	3	5	..	1 S.
Kingland	North London School of Science.	Mackenzie, Rev. C.	Cousens, James	Newton, J.	14	37	..	23	..	6	..	..
Polytechnic	Royal Polytechnic Institution	Mauds, Francis, Captain, R.N.	Webb, W. H.	{ Scott, John Wires, Alfred P. & Jackson, John }	228	245	15	..	..	..	..	1 B.
City of London	Sailors' Home	Herrick, W. P.	Marshall, J. M.	Brooker, John	23	18	..	5	5	5	..	..
Wells Street.	The Institute	Arthy, Rev. W. R. B.	Brooker, John	Jackson, John	36	36	..	..	18	..	1 G.	..
Loughborough	Mechanics' Institution	Callendar, W. Ro- main, Jun.	Rev. G.	Collins, John	36	33	..	3	2	..	..	..
Macclesfield	Modern Free School	Bowker, W. (the Mayor.)	Jarrett, Albert	{ Angell, J. Collins, J. Mellor, J. Spriggs, C. }	290	295	5	..	5	4	1 S.	..
Manchester	Cathedral Schools	Turner, Wright	Noar, William	Hudson, Fearnside	281	265	12	..	87	104	3 S., 4 B., 3 S., 2 B.	..
"	Mechanics' Institution	Ellis, R. P.	Ellis, Robt. P.	Schofield, J.	53	53	1	..	23	14	..	1 S., 1 B.
"	Corporation Street	Gilkes, Edgar	Taylor, Wm.	Stock, H. W. K.	..	13	13	..	..	..	..	..
Middlebro'	Mechanics' Institution	Dumford, Rev. R.	Ward, Rev. O. B.	Wheeler, George H.	..	9	8	1	2	4	..	..
Middleton	National School	Ferryd, Wm.	Waddington, J.	Clement, Leonard	..	14	14	..	..	..	..	..
Nelson-in-Marston	Lomechaye Mills	..	..	..	23	34	6	..	..	10	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.	Increase.		Decrease.		Number of Prizes.		Number of Medals.	
						1884-5.	1885-6.	1884.	1885.	1884.	1885.	1884.	1885.
Upton, St. Leonard's	Schoolroom	Tisson, W.	Betts, Rev. J.	Davis, Uriah J.	40	37	..	3	12	1	..	..	..
Walsall	Christian Institution		Ward, Henry	Sutcliffe, Henry	29	15	15	3	1	..	..	..	..
West Bromwich	Mechanics Institution	Fergie, Rev. T. F.	Peace, M. W.	Birkenhead, E. H.	33	31	..	62	12	2	..	..	..
Wigan	Mowbray House School	Iles, Rev. J. H.	Laingley, J. N.	Jones, John	35	25	..	10	3	4	1 B.	..	..
Wolverhampton	Science and Art Institution	Mumford, A. L.	Meadley, J.	{ Stone, Wm. Burgess, Rev. S. Wheatley, A. }	40	43	3	..	7	10	..	..	..
Wolverton	Mechanics' Institution, Royal Arsenal.	Anderson, James	Keeble, W. D.	Jones, Thomas	60	56	..	4	18	25	2 S.	1 B.	1 B.
Woolwich	National School	Brown, Rev. H.	Wilson, James	Snelus, G. J.	..	23	..	..	..	3	..	1 S.	..
"	Navigation School		Hutcher, M.	Stockton, W.	163	139	..	24	..	2	..	..	..
Yarmouth, Great	Popular Institution	Palmer, Rev. H. V.	Hall, R.	{ Brown, J. Crawley, S. }	..	90	90	..	..	..	..	..	..
York													
SCOTLAND.													
Aberdeen	Mechanics' Institution	Matthews, James	Sinclair, J.	{ Braiser, J. S. Mayer, D. Beveridge, Dr. Jones, J. R. }	34	92	58	..	2	1	..	1 S.	..
"	Navigation School		Kellas, Jas. F.	Macdonald, Margaret	231	285	34	..	..	..	..	..	..
Corack	Girls' School	Sturrock, George	Hourston, S.	Kennedy, John	24	12	..	12	2	7	..	..	..
Dundee	High School	Sturrock, John	Cunning, A. W.		45	52	7	..	5	8	1 S.	..	..
Glasgow	Secular School	{ The Lord Provost Athenaeum Andersonian }	Cunliffe, Rich. S.	{ Mayer, J. Mayer, Mrs. McRae, J. Macchattie, Alex. T. }	130	150	20	..	33	27	1 S.	..	..
"	Athenaeum				21	31	10	..	..	..	..	..	..
"	Andersonian				692	692	..	..	26	15	1 G.	1 S., 2 B.	..
Kilmarnock	New Public School	Aitken, Rev. James	Crawford, Robt.	{ Stevenson, James Dunn, H. S. }	11	20	9	..	..	2	..	..	..
Leith	Navigation School	Lindsay, Wm.	Thomson, Rev. J.	Bolan, James	237	219	..	18	1	..	..	..	..
IRELAND.													
Ballymena	National School	Bowan, Rev. B. W.	Lynch, Rev. John	Black, Robert	..	13	13	..	..	..	..	..	..
Banbridge	Literary and Mutual Improvement Society.	Reilly, James A.	Black, Alexander		..	..	..	..	..	1	..	..	..

TABLE showing the SUBJECTS taught at each SCIENCE SCHOOL, and also the NUMBER of STUDENTS in each SUBJECT.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical and Mechanical Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Accrington -	Mechanics' Institution	14							13	19			8											
Alderley Edge -	Day School-room		14							16														
Almondbury -	King James's Grammar School.																							
Andover -	Mechanics' Institution																							
Ardwick -	Chancery Lane Educational Institute.	8															10							
Ashby-de-la-Zouch -	Mutual Improvement Society's Rooms.																							
Ashton-under-Lyne -	Mechanics' Institution	16	16																					
Bacup -	Mechanics Institution																							
Banbury -	British School -												14											
Barnsley -	Academy				8																			
Birmingham -	Midland Institution			85					23	11														
Blackburn -	Mechanics' Institution																							
Bolton -	Literary Institution								9	20														
Bolton -	Bridge Street School								16	16														
Bolton -	Mechanics' Institution	56	50	50																				
Bolton -	Independent Methodist's School.																							
Bolton -	Holy Trinity Working Men's Institute.																							
Bristol -	Diocesan Trade School																							
Burnley -	Church of England Literary Institution.	70	64	49	20																			
Burnley -	Fulledge Wesleyan School		15																					

ENGLAND.

Table showing the Subjects taught at each Science School, &c.—continued.

Town.	Where held.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Camden Town	Camden Hall	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Great Ormond St.	Working Men's Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Harp Alley	Parochial School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Homerton	Lower Public School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Islington	North London School of Science.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingsland	Royal Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polytechnic	Milk Street, Cheapside	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
City of London	Sailor's Home	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wall Street	The Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Loughborough	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Macclesfield	Modern Free School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Cathedral Schools	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Manchester	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Corporation Street School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Roby Educational Institute	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Middlesborough	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Middleton	National School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson-in-Marsden	Lomeshaye Mills	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Newport	The Athenaeum and Mechanic's Institution.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Newton Heath	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
North Ormsby	The Church Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nottingham	Mechanics' Institution	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Oldham	Parish Church School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE of HONORARY DIPLOMAS granted without EXAMINATION.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Brasier, Professor	Aberdeen	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Carter, E. B.	Stroud, Gloucestershire	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Collingwood, Dr.	Liverpool	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Doman, Rev. J. G.	58, Newport Terrace, Bolton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Foster, C. Le Neve	Royal Institution, Truro	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hearder, J. N.	Plymouth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Henslow, Rev. G.	10, South Crescent, Bedford Square, W.C.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
McOwen, Dr. John	10, College Street, Belfast	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mitchell, Thomas	West End, Truro	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pepper, John H.	Polytechnic Institution, Regent Street, London.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phillip, J.	Science and Art School, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stoekton, W.	9, Montague Place, East India Road, London.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Robinson, Enoch	Dukinfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wilson, Alexander	Banbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE showing CERTIFICATES held by SCIENCE TEACHERS.

Revised by the *Examination of November, 1865.*

The asterisk before a Name indicates that the Teacher was Certificated before the Minute of 2nd June 1859 came into operation.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Abbott, Joseph	Collegiate Institution, Liverpool																							
Adams, George	Newcastle-on-Tyne																							
Adcock, Joseph H.	St. Mark's College, Chelsea																							
Allread, Edwin	Training College, Battersea																							
Allen, Alfred H.	1, Surrey Street, Sheffield																							
Allen, Leonard	Trinity House, Dundee																							
Allen, William	Grammar School, Moulton, near Spalding																							
Allott, James	National School, Ruabon, North Wales																							
Almgill, Thomas	8, Bexley Street, Salford																							
Angell, John	Mechanics' Institute, Manchester																							
Arthey, William	Wilde's Endowed School, Lowestoft																							
Atkins, Edward	St. Martin's School, Leicester																							
Atkins, George	Alberbury National School, near Shrewsbury																							
Bailey, Edward J.	St. Mark's College, Chelsea																							
Bain, Robert L.	Elizabeth Street, Maxwelltown, Dundee																							
Baker, Bernard M.	Newport Pratt, County Mayo																							
Baker, Richmond	Union Workhouse, Witham, Essex																							
Bald, John H.	84, Buccleuch Street, Glasgow																							
Baldock, John H.	14, Claremont Place, North Brixton, London																							
Bannister, Richard	7, Coulson Street, Chelsea, London																							
Barkie, Robert	37, Ship Street, Belfast																							
Barkus, William	1, Charing Cross, St. Helier's, Jersey																							

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Barrett, E.	51, Gloucester St., Regent's Park, London	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..
Barter, William A.	Eliscombe, Torquay	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Bartley, George C. T.	Queen's Walk, Ealing	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Beale, John H.	Science School, Banbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beatty, John	Endowed School, Oldcastle, County Meath	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beckett, T. W.	7, Clayton Street, Birkenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beer, James H. E.	Fore Street, Bodmin	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beesley, S.	St. Paul's School, Trammere, Birkenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Beesley, Thomas	5, High Street, Banbury	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	1	1	..	..	..	..	..	..
Bennett, Alfred M.	Royal School of Naval Architecture, South Kensington.	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Bentley, Buzi	Kirkheaton	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Berriman, John	Training College, Battersea	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Beveridge, Robert	2, Upper Kirkgate, Aberdeen	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	1	..	..	..	..	..	..
Bickerdike, William E.	Dalton Square, Lancaster	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Birkenhead, E. H.	Mining School, Wigan	2	2	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Bithell, Richard	Orphan's Home, Halifax	2	..	..	..	..	..	..	..	..	1	..	..	..	..	..	2	2	..	..	..	..	..	..
Black, Robert	National School, Ballymena	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bicknell, C. A.	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Blay, Daniel	Portland British School, Riding-house Street, London.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bliss, William	Training College, Westminster	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Bocharoff, Alexis	17, Eiton Street, Lower Broughton, Manchester.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Boddie, Adam	Fraserburgh, N.B.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bolan, James	Navigation School, Leith	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Clark, Albert Chas.	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clement, Leonard	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clough, James C.	Grammar School, Dedham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cookman, Abraham	National School, Grantham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Coles, Ferdinand	9, Walpole Street, Chelsea, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Collins, Frederick O.	East Street, Bridport	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Collins, John	Cathedral Schools, Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Collins, Joseph H.	34, Denmark Grove, Barnsbury Park	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Conder, John	St. Anne's School, Wandsworth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Constable, John	Brooke's School, Thorne, Doncaster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cook, Charles L.	National School, Beekley, Oxford	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cook, Thomas H.	Horsham Road, Dorking	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cooke, Mordecai C.	6, Springfield Terrace, York Road, Upper Holloway	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Coomber, Thomas	Trade School, Bristol	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cooper, Charles	St. Mark's College, Chelsea, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cooper, William	St. Stephen's School, Stockport Road, Chorlton-on-Medlock	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Corbin, Pennel G.	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cork, Charles S.	St. Mark's College, Chelsea, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cover, John L.	National School, Weston Harwood, Leeds	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cox, George E.	Hollingsworth National School	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crafts, Thomas	British School, Godmanchester, Hunts	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Crauson, Thomas	37, West Blackhall Street, Greenock	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Craven, Joseph	Staveley, Chesterfield	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Croft, Samuel	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cribb, Thomas	Birkbeck School, Peckham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Finlay, Alex. W. A.	53, India Place, Edinburgh	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Forbes, Robert T.	Banton School, By Denny, N.B.	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ford, Benjamin	Bolckow's Iron Works, Middlesboro'	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Foster, John S.	St. Mark's College, Chelsea, London	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Foster, Benjamin	Westeyan Training College, Horseferry Road.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Freehill, Michael	Model School, Trim	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fryar, Mark	Andersonian University, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fulton, Hugh	22, Brunswick Street, Euston Road	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gatehouse, James W.	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gates, George	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gayne, Arthur J.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gee, William	Union Street, Hyde, near Manchester	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gelstharpe, Charles	Walker Alkali Works, Newcastle	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gibbs, John	Baddow Road, Chelmsford	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gibson, George H.	Church Street, Ashby-de-la-Zouch	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gibstone, Burford W.	6, Victoria Terrace, Rochester Square, Camden Town.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Giles, William B.	Chemical Laboratory, Royal Institute, Manchester.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gill, James	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gledhill, Joseph	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Goffin, Robert	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Goodwin, W. H.	Purleigh, near Maldon, Essex	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grant, James	Hill Top, Burnley	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grant, William	Westeyan School, Selby	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Greenstreet, Wm. A.	Addlestone, Surrey	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical & Machine Drawing.	Building Construction & Naval Architecture.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economic Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Hudson, William	National School, Abertillery, near Newport																							
Hurst, Edwin	St. Mark's College, Chelsea																							
Hurst, Wm. F.	Knighton Street Schools, Leicester																							
Hutton, David C.	Kirk Entry, Wellgate, Dundee	2																						
Hyalop, Lawrence	Albert Villas, Upper Grey Street, Edinburgh.																							
Isherwood, Thomas	Wesleyan Day School, Blackburn																							
Ives, William F.	St. John's School, Limehouse																							
Jackson, Robert	St. Mark's College, Chelsea																							
Jackson, William	Huntingshoe School, Wetherby																							
Jarmain, George	East Parade, Huddersfield																							
Jeffery, Walter	Blue-coat Hospital, Gloucester																							
Jenner, William	5, Chesnut Place, Woolwich																							
Johnston, William	The College, Chester																							
Jones, Alfred	St. Shakespear Terrace, Stoke Newington																							
Jones, Edward	Training College, Westminster																							
Jones, Edz. S. L.	Yarmouth Navigation School																							
Jones, James E.																								
Jones, John	Rose Hill, Handsworth																							
Jones, John	Copper Works School, Llanelli																							
Jones, Richard	St. Mark's College, Chelsea																							
Jones, Thomas	33, Dundas Terrace, Brookhill Road, Plumstead.	3	3																					
Jones, Thomas	63, Little Peter St., Gaythorn, Manchester	3	3																					
Judd, John W.	Wesleyan School, Horncastle																							
Judd, William	High Street, Christchurch, Hants																							

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Mapp, George	National School, Radditch	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Marriott, John T.	British School, Andover	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Marshall, John E.	St. Thomas' Charterhouse	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Martin, William	Trafalgar, Salisbury	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mason, James	100, Upper Thames Street, E.C.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, David	Mechanics' Institute, Aberdeen	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, Elizabeth	50, Gloucester Street, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayer, John	50, Gloucester Street, Glasgow	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mayne, Arthur J.	30, Upper Wellington Street, Dublin	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Meaden, Henry P.	5, George Street, Derby	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mellor, James	Seamless School, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Merrick, Edward	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Merrifield, John	Navigation School, Plymouth	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Millard, George G.	South Kensington Museum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Milliean, William	Training College, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mills, Joseph W.	Highfield, Greenhill, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mitchell, Thomas	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moore, Thomas	7, London Street, Liverpool	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Morris, Mark	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Morton, George H.	National School, Niton, Isle of Wight	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moss, Amos	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Moyle, John	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Muir, Robert	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Muldoon, Charles	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nelson, Robert J.	North End National School, Larne	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Navigation School, Shadwell	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	Practical, Plane, and Descriptive Geometry.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Redgrave, Gilbert R.	18, Hyde Park Gate South, London	..	..	..	1	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..
Rich, Sidney W.	Hare Lane, Esher	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Richardson, Henry	16, Dawson Street, Manchester	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Richardson, Joseph	16, Dawson Street, Manchester	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Rickard, George J.	19, Duke Street, Devonport	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Ricks, George	St. John's Town School, Portsea	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..
Rigg, William	2, Oliver Terrace, Oliver St., Nottingham	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Ripley, Henry J.	Training College, Battersea	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Rivers, Albert	Burghfield, near Oakley	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Roberts, John V.	Gwenap, Redruth, Cornwall	..	3	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Robertson, John	Milton Established Church Sessional School, Glasgow.	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Robertson, John	Bagshot, Surrey	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Robinson, John	Warren Corner, Crondall, Hants	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Robotham, William	School of Mines, Bristol	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..
Rosster, William	11, Greville Street, E.C.	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..
Rowden, William	Spring Grove, London	..	1	1	2	..	..	1	2	1	1	1	1	2	1	..	..	..	2	1	..	..	..	..
Rowland, Evan H.	National School, Llanferres, Mold	..	..	..	..	..	..	..	..	3	..	3	..	..	..	..	..	..	..	..	..	..	..	..
Ruckert, Leopold C.	Union Street, Oldham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rule, Charles H.	Training College, Cheltenham	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Runtz, James	Birkbeck Schools, Kingsland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rushforth, Thomas	Bluecoat School, Wolverhampton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rust, Joseph	11, Victoria Street, Maidenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ryan, Lawrence	Model School, Kilkenny	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Salmon, Wm. R.	Navigation School, Hull	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Salter, Edmund	Ashton-under-Lyne	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
		Practical, Plane, and Descriptive Geometry.	Mechanical & Machine Drawing.	Building Construction & Naval Architecture.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economy Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Snell, Daniel -	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Snelus, George J.	99, Great Marylebone Street, London	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Sollas, William J.	27, Oakley Road, Southgate Road, Islington.	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Sparkes, Arthur J.	National School, Albesbury, near Shrewsbury.	..	..	..	..	..	..	..	..	..	2	3	..	..	..	..	..	..	..	..	..	..	..	..
Spear, John J.	Woodbine Cottage, Newtownnirrey Road, Bray.	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Speers, Adam	Holywood, County Down	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Spencer, James	17, New Street, Charles Town, Halifax	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sprink, John	Cathedral School, Ripon	..	..	..	..	..	..	..	..	..	2	3	..	..	..	..	..	..	..	..	..	..	..	..
Spriggs, Christopher	10, Henry Street, Chorlton-on-Medlock, Manchester.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stanton, George	Berry Hill, Taplow, Maidenhead	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stead, Wilbraham	The Grammar School, Lincoln	..	..	..	..	..	..	..	2	1	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Stevenson, James	New Public School, Kilmarnock	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stevenson, J. M. N.	Carriackfergus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stewart, John	Magdalen Chemical Works, Musselborough	..	..	..	..	..	..	..	..	..	3	3	..	..	..	..	..	..	..	..	..	..	..	..
Stiles, James J.	Sunderland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stirrup, Thomas	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stockton, William	9, Montague Place, East India Road, London.	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Stone, William	Science School, Wolverton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Strachan, Richard	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Strand, Robert	St. Mark's College, Chelsea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stubbs, Richard H. O.	St. Margaret's School, Westminster	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sullivan, M.	2, Brecon Terrace, Moore Park, Fulham	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing Certificates held by Science Teachers—continued.

Name.	Address.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Wheatley, Alfred	Science School, Wolverton																							
Wheeler, George H.	National School, Middleton																							
Whitehead, John E.	St. Mark's College, Chelsea																							
Whitehouse, Henry I.	St. Mark's College, Chelsea																							
Whoor, Edward	Eastington, Stonehouse, Gloucestershire																							
Wild, Robert	St. Mark's College, Chelsea																							
Wild, William L.	St. Mark's College, Chelsea																							
Willcock, Joseph	24, Market Place, Manchester																							
Wiley, Thomas	30, Albion Grove West, Barnsbury, N.																							
Williams, John	St. Mark's College, Chelsea																							
Williams, W. M.																								
Williamson, Stewart	39, Clifton Road East, St. John's Wood																							
Wilson, Thomas	62, Clarendon Street, Nottingham																							
Wintner, William	Trading College, Westminster																							
Winter, William	27, Ash Grove, Bradford, Yorkshire																							
Wire, Alfred P.	Prestbury Road, Macclesfield																							
Wood, Charles H.																								
Wood, Edward	31, Richmond Place, Brighton																							
Woodcock, Fred. W.	The Grammar School, Bosworth, Hinckley																							
Woodhead, William	36, Queen Street, Edgchill, Liverpool																							
Woodward, Chas. J.	Midland Institute, Birmingham																							
Woodlett, John	St. Mark's College, Chelsea																							
Wron, Edmond	Model School, Ballymena																							
Wynn, William T.	St. Mark's College, Chelsea																							
Yates, Frederick	Pennfields, Wolverhampton																							

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised to August 1867.)

15th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
BUT ARE ALWAYS SUBJECT TO REVISION.



LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1867.

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SCIENCE AND ART DEPARTMENT.
COMMITTEE OF COUNCIL ON EDUCATION,
CROMWELL ROAD, SOUTH KENSINGTON.

Lord President, His Grace the Duke of MARLBOROUGH.

Vice-President of the Committee of Council on Education, The Right Hon.
LORD ROBERT MONTAGU, M.P.

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Office hours 10 till 4.

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Assistant Secretary.—Norman MacLeod.

Chief Clerk.—G. F. Duncombe (pro tem.)

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SOUTH KENSINGTON MUSEUM.

Director.—Henry Cole, C.B.

Assistant Directors.—R. A. Thompson; P. C. Owen; Captain E. R. Festing, R.E.

Director of New Buildings.—Lieut.-Colonel Scott, R.E.

Decorative Artists.—J. Gamble; R. Townroe.

Art Referees for the Museum.—R. Redgrave, R.A.; J. C. Robinson, F.S.A.

Editor of Catalogues and Referee for Libraries.—J. H. Pollen, M.A., late Fellow of Merton College, Oxford.

Provisional Librarian for Art Library.—R. H. Soden Smith, M.A., Trinity College, Dublin, F.S.A.

SOUTH KENSINGTON MUSEUM—*cont.*

Division Keepers of Museum Collections.—G. Wallis ; W. Matchwick ; H. Sandham ; R. Laskey.

Assistant Keeper of Museum Collections.—C. B. Worsnop.

Supplementary Assistant Keepers.—C. C. Black, M.A., Trinity College, Cambridge ; R. F. Sketchley, B.A., Exeter College, Oxford ; H. E. Acton ; J. W. Appell, Ph. D. ; A. C. King, F.S.A. ; D. Craven.

Clerk of Collections.—J. B. Rundell.

Supplementary Clerks.—H. Vernon ; A. Masson ; F. Coles, certificated in Science ; F. Groser, certificated in Art ; W. G. Johnson.

Agent for Sale of Examples.—J. Cundall.

Official Photographer.—C. Thurston Thompson.

NATIONAL ART TRAINING SCHOOL

Head Master.—Richard Burchett.

Deputy Head Master.—R. W. Herman.

Mechanical and Architectural Drawing.—H. B. Hagreen.

Geometry and Perspective.—C. M. Clarke.

Painting, Freehand Drawing of Ornament, &c., the Figure and Anatomy, and Ornamental Design.—R. Burchett, R. W. Herman ; W. Denby ; R. Col-
linson ; C. P. Slocombe.

Modelling.—F. M. Miller.

Lady Superintendent of Female Students.—Miss Trulock.

Female Teachers.—Mrs. S. E. Casabianca ; Miss Channon.

Lecturer on Anatomy.—J. Marshall, F.R.S., F.R.C.S.

Lecturer on Botany.—Christopher Dresser, Ph. D. Jena.

ROYAL SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING.

Inspector-General and Director of Studies.—Rev. Joseph Woolley, LL.D.

Principal.—C. W. Merrifield, F.R.S.

Vice Principal.—Henry Martyn Taylor, B.A., Fellow of Trinity College, Cambridge.

Instructor of Naval Drawing.—W. B. Baskcomb.

Instructor in Engineering Drawing.—John Maxton.

Instructor in Marine Engineering.—J. F. Cotterell.

Instructor in Practical Chemistry.—John Davidson.

Instructor in French.—M. Penon.

SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.

*[Important Alterations made since the last edition of the Directory are
printed in Italics.]*

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department, of which the Science and Art Department is a branch, is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100*l.* a year. (See § xviii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given :—

- Subject 1, Practical Plane and Solid Geometry.
- „ 2, Machine Construction and Drawing.
- „ 3, Building Construction *or* Naval Architecture and Drawing.
- „ 4, Elementary Mathematics.
- „ 5, Higher Mathematics.
- „ 6, Theoretical Mechanics.
- „ 7, Applied Mechanics.
- „ 8, Acoustics, Light, and Heat.
- „ 9, Magnetism and Electricity.
- „ 10, Inorganic Chemistry.
- „ 11, Organic Chemistry.
- „ 12, Geology.
- „ 13, Mineralogy.
- „ 14, Animal Physiology.
- „ 15, Zoology.
- „ 16, Vegetable Physiology and Economic Botany.
- „ 17, Systematic Botany.
- „ 18, Mining.
- „ 19, Metallurgy.
- „ 20, Navigation.
- „ 21, Nautical Astronomy.
- „ 22, Steam.
- „ 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to teachers. (See § viii., xv., xviii. to xx.)
2. Grants towards the purchase of apparatus, &c. (See § xxii.)
3. Public examinations in which Queen's Medals and Queen's Prizes are awarded, held at all places complying with certain conditions. (See § xi. to xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., and xix.)

VIII. *Persons are qualified to earn payments on results who have :—*

a. obtained certificates as teachers in any of the before-mentioned sciences at the examinations for teachers of the Science and Art Department held previous to January 1867, or,

b. after the abolition of the above examinations—February 1867—obtained a First or Second Class at the examination specified in § xi.*

No payments are made to a teacher on account of instruction given in subjects in which he is not so qualified.

IX. Suitable premises, with firing, light-
ing, &c., must be found and maintained
at the cost of the locality where the school or class
is held. If at any time the funds do not cover
these requisite local expenses, it must be inferred
that there is no such demand as the Government is
justified in aiding, for instruction in the locality ; and
the assistance of the Department will be withdrawn.

School Pre-
mises.

X. A Local Committee of not less
than five well known responsible persons
must be formed in connexion with every Science

Local Com-
mittee.

* Such examination may be dispensed with in cases where the candidate has taken a degree, the examination for which satisfactorily meets the requirements of the case. Full particulars must be furnished by the applicant, and his diploma sent for inspection.

Class, who will carry out the instructions contained in the Appendix.* (See pages 14 and 18 to 22.)

Examination of Classes. XI. The Science and Art Department holds annually in May (see Science Form, No. 232, page 59*), through the agency of the Local Committees, a public examination of all Science schools and classes, whether taught by teachers qualified as above or not, in any place in the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to qualified teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22*), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in Mathematics, Navigation, Nautical Astronomy, Steam, and Physical Geography are held for the benefit of seafaring men—and for them only—three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

Examination of Classes. XII. A school or class taught by a teacher not qualified to earn payments as above, may, by applying to the Secretary of the Science and Art Department, be examined at the same time and in the same manner as the classes under qualified teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21,* Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible

* Science Directory.

to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of qualified teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same Places of Examination. town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 50 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether Examination of other Students. taught by the qualified teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the Classification of Results. May examination and the quarterly examinations of seamen are classified under the heads of first, second, third, fourth, and *fifth* class. The standard of attainment required may be raised from year to year. For the *fifth* class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of

proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, (1) Students in Science Classes under qualified Teachers; (2) Registered Students in Artisan Classes taught by any Teachers, or (3) bonâ fide Artisans.

Other candidates, if successful, receive instead Cards of merit recording their success.

The following are exceptions to the above rule:—

- a. Teachers earning or who have earned payments on the results of instruction; and
- b. Students who have previously received the same, or a higher class, in the same subject.

—the names of such candidates will simply be recorded in the published lists.

Queen's
Medals.

XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age or by teachers who are earning or have earned payments on the results of instruction. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the ^{Payments to Teachers.} teacher qualified as in § viii. on account of the instruction of students of the Artisan Classes (for definition of Artisan Class *see* Science Form No. 51, page 23) in the manner specified below:—provided that the student has received 25 lessons * at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not necessarily be all given in one year, but may extend over a longer period.

XIX. 1*l.*, 2*l.*, 3*l.*, 4*l.*, 5*l.* are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced in the following ways:

1st. If the student has been previously successful in the same subject, such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4*l.* payment for a second class would, if the student had previously taken a fourth class, be reduced by 2*l.*†

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

3rd. When on this scale they would amount to more than 60*l.* the excess up to 40*l.* is diminished by one quarter, the excess above 40*l.* by one half. Thus payments which on the above scale would be 100*l.* and 150*l.* will be reduced to 90*l.* and 115*l.* respectively. ‡

* It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

† Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

‡ Thus, 100, that is 60+40, is reduced to 60+40−¼ of 40 = 60+30=90. 150, that is, 60+40+50 is reduced to 60+30+25=115.

If the teacher be instructing classes three miles or more apart this deduction will be reduced by the amount of his travelling expenses.

Form of Claim
for Payment.

XX. The claim of a teacher for the payments under these several heads is made on Science Form, No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the Committee of the Science Class or School; or by at least three of the Committee. (See Appendix, page 23.)

School
Register.

XXI. A school register must be kept in each subject on a Form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for
Apparatus.

XXII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to Science Schools and Classes in Mechanics' and similar institutions with a properly constituted Committee (see § x.) A requisition must in these cases be made on Science Form No. 49. (See page 29.)

Instruction in
an Elementary
School.

XXIII. All payments to qualified teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect of any instruction in Science that may be given during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of
Elementary
School
Premises.

XXIV. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Depart-

ment, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other Forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

** * * The Directory for Science Schools and Classes is sold by Messrs. Chapman and Hall, 193, Piccadilly, London, or may be obtained from the Secretary, Science and Art Department, by enclosing six postage stamps.*

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND MEMBERS OF SCIENCE COMMITTEES.

Dates.	
Before 30th November.	Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.
Constantly - - -	To visit the School and see that the Register is kept from day to day, and that everything is regular.
Before 1st January	To carefully fill in and send to the Department Form No. 120.
Before 31st March	To send Form No. 119 applying for examination in May.
Before 24th April -	To see that Form No. 91 is hung up in the School-room.
On the 27th April	If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate <i>at once</i> to the Department.
During the May examinations.	The examination papers for each evening will leave London by the night mail two evenings before, <i>i.e.</i> , Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent <i>at once</i> to the Department.
On the evening of examination.	The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.
After the May examinations.	On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed. To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 244a. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108. To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50*l.* per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1868 examination three of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grade in any subject	-	-	-	-	9 marks.
To a 2nd „	„	-	-	-	7 „
To a 3rd „	„	-	-	-	5 „
To a 4th „	„	-	-	-	„
To a 5th „	„	-	-	-	1 „

and in addition—

For a gold medal	„	-	-	-	10 „
For a silver medal	„	-	-	-	7 „
For a bronze medal	„	-	-	-	5 „

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

EXHIBITIONS AND FREE ADMISSIONS AT THE GOVERNMENT SCHOOL OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are ten Royal Exhibitions to the Government School of Science, Dublin, of the value of 50*l.* per annum, entitling the holders to free admission to all the lectures and to the chemical and metallurgical laboratories at the Government School of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the school.

At the May 1868 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz. :—

To a 1st grade in any subject	-	-	-	9 marks.
To a 2nd " "	-	-	-	7 "
To a 3rd " "	-	-	-	5 "
To a 4th " "	-	-	-	3 "
To a 5th " "	-	-	-	1 "

and in addition—

For a gold medal, "	-	-	-	10 "
For a silver medal, "	-	-	-	7 "
For a bronze medal, "	-	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Government School of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

FORM of APPLICATION for the ROYAL EXHIBITIONS to the ROYAL SCHOOL OF MINES, Jermyn Street, London, and the GOVERNMENT SCHOOL OF SCIENCE, Dublin.

The following candidates at the recent May Examinations are candidates for the Royal Exhibitions at the* _____

and they are either—

1. Under 21 years of age.
2. Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
3. Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
 - a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
 - b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
 - c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
4. That they are entitled to be considered as a special case on the following grounds :—

We hereby certify that the above particulars are correct.

 _____ { *Chairman or Secretary.†*
 _____ { *Two members of the*
 _____ { *Committee.†*

* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.

† Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS
AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.

- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artisans or operatives, or their children, or can claim as such (see Science Form, No. 51 ; and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.

5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- [f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
- g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Heads of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
- h. It is absolutely necessary that at least two such responsible persons should agree to act.
- i. The Committee must consist of a Chairman, Secretary, and at least three other Members.
- k. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
- l. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
- m. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1*l*. annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1*l*. in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
- n. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by _____

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
 <i>Chairman.</i>		
 <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules f, g, h, i, and k.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS,

To be made on its establishment, and annually (before the 1st January) of its continuation.

Name of Town _____

Place, as Mechanics' Institution, &c., in which the Classes are held _____

Name of Street, No., &c. _____

Name of Teacher or Teachers _____

Their private addresses _____

Total No. of individual Students _____

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for *new* members to *sign* the form undertaking to perform the various duties.)

SCIENCE FORM, No. 119.
APPLICATION FROM **SCIENCE SCHOOL FOR EXAMINATION IN MAY.**
To be sent to the Secretary of the Science and Art Department before the end of March.

Number of students under instruction during the year Number intending to present themselves for examination Number intending to present themselves for examination not belonging to the class	I.	Practical Plane and Solid Geometry.
	II.	Mechanical and Machine Drawing.
	III.	Building Construction.
	IV.	Elementary Mathematics.
	V.	Higher Mathematics.
	VI.	Theoretical Mechanics.
	VII.	Applied Mechanics.
	VIII.	Acoustics, Light, and Heat.
	IX.	Magnetism and Electricity.
	X.	Inorganic Chemistry.
	XI.	Organic Chemistry.
	XII.	Geology.
	XIII.	Mineralogy.
	XIV.	Animal Physiology.
XV.	Zoology.	
XVI.	Vegetable Physiology and Economic Botany.	
XVII.	Systematic Botany.	
XVIII.	Mining.	
XIX.	Metallurgy.	
XX.	General Navigation.	
XXI.	Nautical Astronomy.	
XXII.	Steam.	
XXIII.	Physical Geography.	

Total number of students * under instruction during the year _____

Total number of students * intending to present themselves for examination _____

Name and address of the person to whom the examination papers are to be sent. _____

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

Application from _____ Science Teacher in _____
School or Institution at _____ for payment.

- (1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .
- (2). That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (3). That the under-mentioned students are *artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.*

Two mem-
bers of
Committee.

Teacher.

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deductions.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Position in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade.		
&c.							

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On behalf of the Committee of the School, We, the undersigned, beg leave to recommend that the Teacher, Mr. _____ be allowed to claim the allowances on the following students, whom we consider may fairly be taken as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.

- a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is not employing apprentices, journeymen, &c.
- b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so such as shopkeepers (who have only petty stocks and employ no one but members of their own family), policemen, coast-guards, &c.
- c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, &c.

We certify to the best of our belief—

- (1). That he has given them (25) lessons at least during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (2). That they, or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
- (3). That the following particulars on which the Teacher grounds his application are correct.

Secretary.

Two mem-
bers of
Committee.

I hereby certify that the following particulars are correct.

Teacher.

NAMES OF PASSED STUDENTS CLAIMING AS INDUSTRIAL CLASSES.

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success with the proper deductions.

Under the names of students in category "c" a line must be drawn.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination. Subject. | Grade.	Highest Position in same subject at any previous Examination.	State Category a, b, or c.	Payment claimed.
&c.							

**The Secretary,
Science and Art Department.**

(The following particulars will be filled up at South Kensington.)

Examined and found correct to the extent of

Approved _____ day of _____ 186
_____ day of _____ 186

[SPECIMEN.]

Science Form, No. 51.
South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from *John Smith*, Science Teacher in the *Science School*
or Institution at *Midhurst* for payment.

On behalf of the Committee of Management of this School, We do
hereby certify:—

- (1.) That *Mr. J. Smith* has duly performed the various duties devolving upon him as a Science Teacher in the School, during the year ending 31st day of *May* 1865;
- (2.) That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed;
- (3.) That the under-mentioned students are *artizans or operatives* * in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, { Two mem-
James Robinson, { bers of
Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's name must be placed his several successes (if he has more than one); and in the last column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Position in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade		
<i>Adams,</i>	<i>James,</i>	22	<i>Carpenter,</i>	<i>X.</i>	<i>1st</i>	—	£ s.
"	"	"	"	<i>XI.</i>	<i>2nd</i>	<i>4th</i>	5 0
<i>Barber,</i>	<i>John Wm. Henry.</i>	14	<i>Butcher (f)</i>	<i>XIV.</i>	<i>Pass</i>	—	1 0
				<i>X.</i>	<i>1st</i>	<i>2nd</i>	0 10
<i>Smith,</i>	<i>William,</i>	12	<i>Baker (f)</i>	<i>XI.</i>	<i>4th</i>	—	2 0
				<i>I.</i>	<i>1st</i>	—	5 0

* Should the Teacher have instructed any Students who may fairly be considered to belong to the industrial classes, but whose wages are paid at longer intervals than a week, or who do not support themselves by their own manual labour the claims on their account must be made by the Committee of the school on the form on page 3, when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _____ Secretary of the Local
Committee for the Science School or Class at _____
for payment of allowance for duties connected with the School, and for
superintending the examination.

Sir,

Being entitled to payment according to the regulations of the
Science "Directory,*" for duties connected with the Science Class at _____
and for superintending the arrangements
for carrying out the examinations on _____ the following days
in May 186 , I request that the sum of £ _____ may
be paid to me, being the authorized fee.

Dates of Examination.

Dates of Examination.

Dates of Examination.

I am, Sir,

Your obedient Servant,

The Secretary,

Science and Art Department.

**CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS,
&c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES
(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),† IN
PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.**

1. The Lords of the Committee of Council on Education, having had
under their consideration several applications from the managers and
masters of Mechanics' and other Institutions, for grants to be made to
them of Apparatus and Illustrations, recommended by the Science and
Art Department for teaching science, think it necessary to adopt some
general principle which shall regulate the decisions of the Committee in
reference to such applications.

* £1 annually for furnishing the returns, &c. specified on Science Form No. 170, con-
nected with any Science school or class, and £1 in addition for each day's examination
held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Me-
chanics' Institutes, not taught by a certificated teacher, under the same conditions,
that is, the Department will aid them to the extent of 5*l.*

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

"1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

"2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

"3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the *risk* of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

FORM of REQUISITION which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

No. 1 application to be filled in by Requisitionist, with full particulars.

	Male	Female	
Having _____			(*) Pupils (Artizans or Operatives) of the Science Class.
(*) Erase the words that do not apply.			
and _____			(*) Scholars or Members of Poor School or Mechanics Institute.
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____ at _____
per _____ at _____
Dated this _____ day of _____ 186 .
Signature of Requisitionist.

2. Requisition sent to M _____ Agent, this _____ day of _____ 186 .
and authority given for the supply of Articles to the extent of _____
Net Sum

No. 2 to be filled in by the Department.

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186 .
Articles (Retail Price) £ _____
Deduct as above,—
Aid by Department £ _____
Add, for packing £ _____
Total to be paid by Requisitionist

No. 3 to be filled in by agent on transmission of the invoice.

4. Amount £ _____ received from schools this _____ day of _____ 186 .
Agent.

No. 4 and 5 to be filled in by agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 .
Agent.

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 .
Requisitionist.

No. 6 to be filled in by Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

3.* All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided. All arrangements for the accommodation of candidates must be completed by 6.30 p.m.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present. No persons not on the Committee are permitted to be present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day before that fixed for the examination.

7.* The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee, and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

8.* The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

9.* When the candidates are seated and the papers given out, the Committee will see that the candidates *commence* by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

10.* Candidates must on no account bring anything with them into the examination room,‡ except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed.§ Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

11.* Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

* When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

† Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, *i.e.*, pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. *But nothing must be torn off the form.*

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

13.* The examination papers being given out no candidate must be allowed to return after having once left the room.‡ On a candidate leaving the room his papers must be taken up.

14.* At 10 p.m., precisely§, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c. it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15.* Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with *to the letter*. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures.	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

† Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

‡ It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

§ Except in the Drawing Examinations, subjects 1, 2, and 3, then the hour is 11 p.m.

SYLLABUS OF THE SUBJECTS IN WHICH EXAMINATIONS ARE HELD BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to. The examination in each subject is distinct. Mention is made of text-books solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2*d.* each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Geometrical Drawing, &c.	Prof. T. Bradley.
Mechanical Physics	- Rev. B. M. Cowie, M.A.
Chemistry	- - - Prof. Hofmann, F.R.S.
Geology	- - - Prof. Ramsay, F.R.S.
Mineralogy, &c.	- Prof. W. W. Smyth, M.A., F.R.S.
Zoology	- - - Prof. Huxley, F.R.S.
Botany	- - - Edwin Lankester, M.D., F.R.S.
Navigation and Nautical Astronomy.	J. Riddle, F.R.A.S.
Physical Geography	- Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physiology and Economic Botany.	Edwin Lankester, M.D., 3rd February. F.R.S.
Lecture II. Mechanical Physics	Rev. B. M. Cowie, B.D. 10th February.
Lecture IV. Mining	- - - W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

A teacher will not receive any payments for Subjects II. or III. until he is qualified in I.

Subject I.—Practical Plane, and Solid Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is assumed to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c. Two or three questions in the first or easy paper are intended to test his skill in these respects.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of objects of construction, which are always symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* division of scales. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.

6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 \pm b^2}$, &c.

7. To construct a triangle, any three parts being given.

§ 1. Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites.

§ 2. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

Both papers contain questions from sections, 1, 2, 4, 5, but those of the second or more difficult paper are chiefly from sections 4, 5, 7, and 8, and only rarely from 3, 6, 7, and 9.

For the preceding part of the course, a fair knowledge of the first four books of Euclid is necessary, some acquaintance with elementary trigonometry is also desirable.

Constructions in Solid Geometry.

(Descriptive Geometry.)

A general knowledge of the principles of *projection* on two (co-ordinate) planes, as necessary to define or represent any geometrical solid, is necessary to gain any certificate in this subject. These projections are termed *plans, elevations, profiles, or sections.*

The questions in the first or easy paper demand only this elementary knowledge, the candidate being required to represent by their projections simple solids, such as prisms and pyramids, or others formed by their combinations.

But to obtain a second or first class the candidate must be acquainted with the methods of solving problems on the combinations of points, lines, and especially planes, independent of any solid form or *volume* of which they are the elements.

He should also know something of the geometry of *curved surfaces*, as the sphere, cylinder, and cone, and of the mode of representing all surfaces graphically by the projections of their generators. For the following subjects he must know how to determine planes to touch or tangential to such surfaces; but candidates are not expected to be more than generally acquainted with these subjects. Occasionally, however, easy questions in the following are inserted in the second paper.

Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., must all possess some knowledge of it.

The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection

Is usefully employed in the representation of works, chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is increasing: it is readily understood, and can be practised by anyone who has gone through the previous articles of this section.

Perspective or Radial Projection

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.) is essential.

The following are some of the best works on the subject of Practical Geometry, but the list is not given as a complete one:—

For Theoretical Geometry.—1. *Geometry, Plane, Solid, and Spherical*, &c. (Library of Useful Knowledge), published originally by Baldwin and Cradock, undoubtedly the best work on the subject.—2. *Geometry*, &c., by Mr. Bell, in Chambers's Educational Course, both comprehensive and excellent.—3. There are excellent elementary works based on Euclid in Gleig's School Series, and in that published by Messrs. Galbraith and Haughton in Ireland, also in Weale's Series, &c. &c.

For Practical Geometry.—Bradley's *Geometrical Drawing*, published for the Committee of Council on Education by Messrs Chapman and Hall. — Bradley's *Practical Geometry, Perspective and Projection* (Library of Useful Knowledge). — Hall's *Elements of Descriptive Geometry for Students in Engineering*. — Heather's *Descriptive Geometry for Students in Engineering* in Weale's Series. — Also works by Winter, Burchett, and Binns.

French works on this subject are numerous and excellent, by Lacroix, Lefebvre de Fourcy, Leroy, Le Vallée, Adhemar, Bardin, &c. &c.

Subject II.—Machine Construction and Drawing

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture and Drawing.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. *Arithmetic generally.*
2. *Geometry.*—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.
3. *Algebra.*—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.
4. *Plane Trigonometry.*—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and *vice versa*. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90° , 45° , 60° , 30° , 180° , 120° , 150° , &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulae for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, $2A$, $3A$, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in terms of $\frac{A+B}{2}$ and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulae for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:—

- (1.) Geometry. The first book of Euclid.
- (2.) Algebra, to simple equations and problems (inclusive).
- (3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class:—

- (1.) Geometry. The first three books of Euclid.
- (2.) Algebra, to quadratic equations.
- (3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

1. **Algebra.**—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.

2. **Plane Trigonometry.**—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.

Spherical Trigonometry.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice: he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines. The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended :—Willis's *Mechanism* ; Baker's *Elements of Mechanism* ; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics* ; Goodeve's *Elements of Mechanism*.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated ; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds ; of pitch ; of harmony and discord ; to commit to memory the rates of vibration of the several notes of the gamut ; to be able to make sonorous vibrations visible by means of glass plates and membranes ; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light ; to be able to state the laws of both ; to explain what is meant by total reflection ; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it ; why a stick appears bent when dipped obliquely into water ; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex ; to describe the characters of their images, whether erect or inverted ; magnified or reduced ; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye ; the conditions of distinct vision, the use of spectacles ; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light ; to be able to describe the spectrum produced by refraction with a prism ; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer ; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation ; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined ; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies ; to know what is meant by the coefficient of expansion, and how it may be determined ; to give illustrations of the enormous power of heat in

producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Text Books:—See next subject.

Subject IX —Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Volume weights. Combining weights. Atoms and molecules. Chemical symbols and their use in the explanation of chemical changes. Quantivalence.

The non-metallic elements :

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Oxygen. Combustion.

Sulphur. Sulphuretted hydrogen. Sulphurous acid, sulphuric acid, hyposulphurous acid, hyposulphuric acid. Manufacture of oil of vitriol. Bisulphide of carbon.

Chlorine. Hydrochloric acid. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Hydrobromic acid and bromic acid.

Iodine. Hydriodic acid. Iodic acid, periodic acid.

Fluorine. Hydrofluoric acid.

Nitrogen. Ammonia. The oxides of nitrogen.

Phosphorus. Phosphoretted hydrogen. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid : ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Chlorides of phosphorus. Manufacture of matches.

Carbon. Marsh gas. Carbonic oxide. Carbonic acid. Olefiant gas. Manufacture of coal gas. Nature of flame.

Silicium. Silicietted hydrogen and silicic acid. Hydrofluosilicic acid.

Boron and boracic acid.

The metals : *Potassium*. Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. *Sodium*. Manufacture of soda.

Barium. *Strontium*. *Calcium*. Mortars.

Spectrum analysis ; its principles and applications.

Magnesium, *Aluminium*. Manufacture of glass and porcelain.

Manganese. *Iron*. Composition and properties of cast iron, wrought iron, and steel.

Cobalt. *Nickel*. *Chromium*. *Zinc*. *Cadmium*. *Copper*. *Lead*. Manufacture of white lead.

Bismuth. *Mercury*. *Tin*. *Arsenic*. Course of analysis in cases of poisoning.

Antimony. *Silver*. *Gold*, and *platinum*. Principal compounds of the metals with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is the list of Apparatus and Re-agents with which Candidates make their analysis at the examination :—

APPARATUS.

Test tubes and stand.	Iron spoon.	Platinum wire and foil.
Metal filter stand.	Tongs.	Funnels.
Wash bottle containing distilled water.	Pestle and mortar.	Cut filters.
Spirit lamp.	Porcelain dishes.	Sulphuretted hydrogen apparatus.
Black blowpipe.	Watch glasses.	Platinum crucible.
Charcoal for blowpipe experiments.	Porcelain crucible.	Herapath's blowpipe,
	Triangles.	Stirring rods,
	Test tube cleaner.	

RE-AGENTS.*In the liquid state.*

Sulphuric acid.	Ammonium, oxalate.	Acetic acid.
Hydrochloric acid.	Sodium, phosphate.	Hydrofluosilicic acid.
Nitric acid.	Barium, chloride.	Lead, acetate.
Hydrosulphuric acid.	Calcium, chloride.	Iron, sesquichloride.
Potassa.	Lime water.	Potassium, ferrocya-
Ammonia.	Calcium, sulphate.	nide.
Ammonium, chloride.	Potassium, sulphate.	Potassium, sulpho-
Ammonium, sulphide.	Magnesium, sulphate.	cyanide.
Ammonium, carbonate.	Potassium, chromate.	Platinum, chloride.
Ammonium, molyb-	Oxalic acid.	Silver, nitrate.
date.	Tartaric acid.	

In the solid state.

Sodium, carbonate.	Borax.	Blue and red litmus
Potassium, nitrate.	Lime.	paper.
Potassium, cyanide.	Iron, sulphate.	

Subject XI.—Organic Chemistry.

Definition of organic bodies. Their ultimate analysis. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the molecular weights of organic acids and bases. Determination of the vapour-density of volatile bodies. Law of substitution. Synthesis of organic compounds.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol. Aldehyde and acetic acid, and their homologues. Chloride of acetyl. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Tartaric and citric acids. Tannic acid.

Aromatic bodies. Benzoic alcohol, aldehyde, and acid; their derivatives, their homologues. Salicylous and salicylic acid. Gallic and cinnamic acid. Hippuric acid.

Ammonia and its derivatives. Amides and amines: their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation. Colours derived from coal tar.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books.—Graham's *Elements of Chemistry*, Miller's *Elements of Chemistry*, Fownes' *Manual of Chemistry*, Bloxam's *Chemistry*, Inorganic and Organic, Galloway's *First and Second Steps in Chemistry*, Williamson's *Chemistry for Students*, Frankland's *Lecture Notes*, Roscoe's *Lessons in Elementary Chemistry*.

Subject XII.—Geology.*General Principles.*

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks, such as ordinary marine strata of shales, sandstones, conglomerates and limestones

—delta formations—freshwater and terrestrial beds, and the signs by which you can distinguish these, such as the nature and mode of the occurrence of the genera of animals and plants that are found in them.

3. The theories of central heat, and of the consolidation of the earth from a state of igneous fusion.
4. The mode of occurrence of igneous rocks, intrusive bosses, lavas, volcanic ashes, and dykes.
5. Volcanoes and volcanic phenomena; the origin of volcanoes and the cause of eruptions.
6. Elevation and depression of land; the distribution and origin of mountain chains. Denudation of the earth's surface, origin of valleys, &c.
7. The ordinary mineral substances that enter into the composition of rocks, such as granites, diorites, basalts, &c. Gneissic rocks, sandstones, slates, shales, clays, &c. The origin of limestones. The origin of mineral veins or lodes.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks. Origin of cleavage.
11. Explanation of geological terms.
12. Definition of zoological terms used in geology, such as genus, species, bivalve and univalve shells, cephalopod, brachiopod, palæozoic, &c. &c.
13. The meaning of breaks in the succession of life (changes of genera and species) in the different formations.

Stratified Formations, &c.

1. Description of the Cambrian and Silurian strata, their physical characters, fossils, and any unconformities that exist in the British Silurian strata.
2. Description of the Old red sandstone and Devonian rocks, characters and fossils. Slate and slate quarries, building-stones, limestones, and marbles of these and the Silurian formations.
3. The Carboniferous limestone and Coal-measure series. Character, fossils, and mode of formation. Nature of the plants of the Coal-measure epoch. Their mode of growth. Origin of coal, its mode of occurrence, and how the vegetable matter became changed into coal. Mode of occurrence of the ironstone of the Coal-measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Limestone quarries, marbles, and building-stones. Clay pits and potteries of the Carboniferous strata. Fire clay. Alum shale, &c.
4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones. Great break in the succession of life between the Palæozoic and Mesozoic or secondary strata.
5. The New red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits. Origin of rock salt and brine springs.
6. The Rhetic beds and Lias, their subdivisions, fossils, building-stones and hydraulic limestones, and clay pits.
7. Oolitic rocks. Subdivisions, leading marine and land fossils. Limestones, clay pits, coal, jet and other economic products.
8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clays. Great break in the succession of marine fossils between the Oolitic and Cretaceous strata.
9. Cretaceous rocks. Subdivisions, lithological characters, fossils, building stones of Lower Greensand. Gault, its phosphatic nodules

and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints. Great break in the succession of marine fossils between cretaceous and eocene strata.

10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
11. Miocene or middle tertiary strata, marine and freshwater, fossils, &c.
12. Crag. Its subdivisions, chief fossils. Origin of its phosphatic remains.
13. The glacial period, boulderclay, and evidence of old glaciers in Britain, &c. River gravels, &c. of post-tertiary age, and their contents.
14. Disturbance and denudation of strata in successive periods, &c.
15. Unconformities, faults, and fractures.
16. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
17. Water-bearing strata, and underground drainage. Artesian and other wells.
18. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds of solid rock, in superficial detritus and in lodes.
19. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.

Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Jukes' *Geology for Schools*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*; Ramsay's *Physical Geology and Geography of Great Britain*; Woodward's *Recent and Fossil Genera of Shells*.

Subject XIII.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity: 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.
- E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.

- g. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London. 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood on the *Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

Candidates must be prepared to answer questions upon the following points in Human Anatomy and Physiology :—

The plan of the human body and the arrangement of its parts.

The meaning of the terms organ and tissue.

The general structure and disposition of the principal organs and tissues.

The ultimate chemical composition of air, water, carbonic acid, urea ; of protein, fat, starch, and sugar ; of bone-earth and horn.

The meaning of the term function.

The general working of the body considered as an engine ; its waste, and the mode in which that waste is made good.

The particular functions of the different organs.

The structure and working of the heart and blood vessels.

The nature of the lymphatics and lacteals.

The course of the circulation of the blood, and the evidence that it circulates.

The pulse and the sounds of the heart.

The regulation of the circulation by the nervous system.

The structure and properties of blood corpuscles.

The process of the coagulation of the blood.

The proximate chemical constituents of the blood, and the uses of that fluid.

The difference between arterial and venous blood. The way in which that difference is brought about. The working of the chest and lungs in respiration.

The difference in chemical composition between inspired and expired air. The daily loss of carbon and gain of oxygen. Stationary and tidal air.

The respiratory murmurs. The nature of asphyxia, and the necessity for fresh air.

The structure and uses of the kidneys. The daily loss of nitrogen in the shape of urea, of uric acid and of saline matters, by the kidneys.

The structure and uses of the skin.

The relations of the lungs, skin, and kidneys.

The structure and uses of the liver. The nature of the bile.

The development, distribution, and regulation of the heat of the body.

The composition of aliments: proteids, fats, amyloids, and minerals.

Essential and accessory alimentary substances. Economy of a mixed diet.

The digestion and absorption of aliments.

Cilia and muscles; their structure and properties. The levers of the body. The structure of joints. Locomotion.

The structure and working of the larynx. Voice and speech.

The muscular sense. The organs of the higher senses, touch, taste, smell, hearing, and sight, and the manner in which they intermediate between the cause of the sensation and the expansion of the nerve. The adjustment of the eye to distances. The theory of the stereoscope.

Simple and compound sensations.

Auditory and ocular spectra. Auditory and optical delusions.

The general structure of the nervous system. The properties of nerves, and of the spinal cord, brain, and sympathetic. Vasomotor nerves.

Reflex actions, natural and acquired.

Text-books for Physiology.—Carpenter's *Animal Physiology*; Kirke's *Manual*; Huxley's *Lessons in Elementary Physiology*.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms*, *classes*, and *orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be prepared to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia*, *Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. Asexual multiplication as exhibited by these creatures. Types—*Hydra*, *Sertularia*, *Plumularia*, *Actinia*, *Corallium*, *Fungia*, *Oculina*.

iii. Starfishes, sea urchins, and *Holothuræ*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepang. Types—*Uraster*, *Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lumbricus*, *Hirudo*, *Distoma*, *Tænia*, *Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Læbellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells" (*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads. Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodilus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers. Development of the fowl's egg. Artificial hatching. Migration,

and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implantal mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*, *Cervus*, *Bos*, *Ovis*, *Felis*, *Phoca*, *Phocæna*, *Dasybus*, *Halmaturus*, *Ornithorhynchus*.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Zoology.—Dallas's *Natural History of Animals* in Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Greene's *Manual of the Protozoa*; Rymer Jones's *Animal Kingdom*.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corollal, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Henfrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Algæ*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Phleum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arundo*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpacæ*, *Cannabinaceæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buarus*.

16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
 17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
 18. *Labiataæ*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
 19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
 20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
 21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.
 22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellateæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbellifereæ*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Æthusa*, *Oenanthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Crucifereæ*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alliaria*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position

in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for; description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits.

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's Report on Cornwall and Devon. *Greenwell's Treatise on Mine-Engineering.* *Dunn on the Winning and Working of Collieries.* *Hedley on Colliery Working and Ventilation.* *Smyth's Rudimentary Coal and Coal Mining.* Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines.* Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes;

treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian, and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. *Elementary Principles.*—Problems relating to latitude, longitude; differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale, Construction of tables of meridional parts,

Description and use of sextant, with the theory, adjustments, and errors.

NOTE.—Candidates for certificates as teachers of Navigation will be required to possess a competent knowledge of the whole of the above syllabus, and to have obtained a certificate in elementary mathematics and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To “pass,” as far as principles of plane sailing. The compass and correction of courses.

For honourable mention.—As far as Mercator’s sailing, with examples.

For third, second, and first class Queen’s prizes, a proportionate knowledge of the remainder.

Subject **XXI.**—**Nautical Astronomy.***

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon’s semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon’s meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon’s declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon *below* the pole and by pole star. Latitude by altitude of sun or other heavenly body *near* the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson’s Practical Information. Sumner’s method of finding longitude and latitude.

Method of double altitudes, Ivory’s and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

OBS.—In all the above problems the demonstration of the rules as well as *accurate* practical working is required.

NOTE.—Candidates for certificates as teachers will be required to possess a competent knowledge of all the above syllabus, and to have obtained a certificate in the elementary mathematics, and passed in higher mathematics as far as spherical trigonometry inclusive.

For students.—To “pass,” a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

For "honourable mention," the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

1. *General Properties of Steam.*—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.
2. *Steam Engine.*—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish—High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser gauge. Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors. Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
3. *Boilers.*—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.

4. *Calculations.*—Methods of measuring efficiency of steam engines.

Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. *Practical working.*—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.

6. *Indicator.*—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—*The Marine Steam Engine*, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's *Indicator and Dynamometer*; De Pambour's *Theory of the Steam Engine*.

NOTE.—No certificate as a teacher of steam will be given unless the candidate has obtained a certificate in elementary mathematics and theoretical mechanics; and no first grade certificate, unless he has taken a certificate in higher mathematics.

Subject XXIII.—Physical Geography.

The following very brief outline of the principal branches of this subject may be useful:—

- a. So much elementary astronomy as relates to the position of the earth in the solar system, its magnitude and rotation, and the influence of the sun and moon on terrestrial phenomena.

- b. So much of elementary physics and inorganic chemistry as includes the nature and mode of action of the physical forces and the composition of rocks.
 - c. So much of elementary geology and mineralogy as includes a knowledge of the nature of rocks, their superposition, succession, and disturbances.
 - d. So much of palæontology as includes a knowledge of the distribution of life in time.
 - I. The distribution of land. Form of land, continental and insular. Elevation of land. Mountains. Plateaux or table-lands. Low plains. Valleys. Deltas. Grouping of islands.
 - II. Phenomena of water. Oceans and inland seas. Composition and temperature of oceans. Movements of water. Tides and currents. Waves. Lakes. Rivers and river systems. Waterfalls. Circulation of water on the globe. Ice. Glaciers. Springs.
 - III. Phenomena of the atmosphere; its nature and composition. Effects of heat on air. Winds. Periodic winds. Storms of various kinds. Electric storms. Magnetic storms. Effects of moisture in the air. Dew. Clouds and rain. Estimate of rain-fall. Climate and weather.
 - IV. Volcanic and earthquake phenomena. Distribution of volcanoes. Volcanic groups. Nature of an eruption. Nature of earthquakes. Range of earthquakes. Statistics of earthquakes. Result of volcanic action and upheaval on the physical condition of the land.
 - V. Distribution of vegetation on the globe in space, horizontal and vertical. Influence of climate and soil on natural groups of plants. Representative forms of plants. Range of cultivated plants.
 - VI. Distribution of animals in space. Zones of height in the air and of depth in water. Corresponding forms of animal life in different zones or belts. Relation between parallels of latitude and zones of height or depth. Special distribution of certain classes and groups of animals.
 - VII. Distribution of plants and animals in time.
 - VIII. Ethnology. Families of the human race. Geographical limit of certain races. First introduction of the human family. Modification of the races of men. Influence of man on vegetation and on animals. Extinction of races by human influence. Influence of man on inorganic nature:
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SCIENCE FORM, No. 232.

CIRCULAR MEMORANDUM TO SCIENCE SCHOOLS
AND CLASSES.

By the advice of the Examiners in Science, the Lords of the Committee of Council on Education have sanctioned the following rules for the examination of Science Schools and Classes in May :—

1. That there shall be two examination papers in each subject ; one of which (the first) will be an easy paper, the other (the second) more difficult.

2. That the candidate shall be allowed to select questions out of either the first or the second paper ; but not out of both.

3. That the candidate shall be restricted to a certain number of questions in each paper—the number which he may fairly answer in the time allowed—and that the paper shall consist of about half as many more questions. Thus, if eight questions in a paper can fairly be answered in the three hours, the paper will consist of about twelve questions, and the candidate will be allowed to attempt any eight of those, but no more.

4. That the 5th and 4th class shall be obtained from the first paper only, and the 1st and 2nd class from the second paper only ; whilst the 3rd class may be obtained from either the first or the second paper.

Thus, for instance, if the candidate is restricted to eight questions in the first paper and to ten in the second paper in a subject, then the number of marks attached to some eight and some ten of those questions respectively will be 100, and 40, 60, and 80* marks in the first paper will give a 5th, 4th, or 3rd class respectively, while 40, 60, and 80 marks in the second or difficult paper will give a 3rd, 2nd, or 1st class. The 3rd class will thus be obtained either by very good answering in the easy paper or by fair answering in the difficult.

5. Teachers are recommended to explain the system fully to their pupils before they come up to examination, and, if possible, from their knowledge of the students' attainments, to advise them which paper to attempt.

* These per-centages are only given as examples. The scale may vary from time to time.

LIST of SCIENCE SCHOOLS, giving the NUMBER of STUDENTS returned as under INSTRUCTION in MAY 1866 and MAY 1867,
and the NUMBER of PRIZES and MEDALS obtained in MAY 1866 and MAY 1867.

Schools established since May 1866 are in Italics.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1866.	1867.			1866.	1867.	1866.	1867.
ENGLAND.												
Abingdon	British Schoolroom	St-ange, W. A., D.D.	Davis, John	Gubb, Edwin J.	30	30	..	..	6	..	..	..
Accrington	Mechanics' Institution	Ingram, J.	Ratcliffe, Wm.	Gunn, W.	23	21	..	2	..	..	..	..
Alderley Edge	Day School Room	Consterdine, Rev. J. W.	Railton, G. W.	Jones, Thomas	21	14	..	7	4	..	..	..
Almondbury	King James' Grammar School,	Dyson, Edward	Jones, J. W.	{ Easther, Rev. A. - } { Jarnain, George - }	20	28	8	..	2	..	..	..
Andover	Mechanics' Institution	Clarke, T. P.	Footner, Richd.	Marriott, J. T.	37	45	8	..	4	..	..	..
Ardwick	Westeyan School	Rumney, Robt.	Lawton, Thomas	Hurst, W.	..	10	10	..	..	..	..	..
Ashby-de-la-Zouch	Mutual Improvement So- ciety's Rooms.	Smith, H. E.	Dalby, John	Gibson, G. H.	34	37	3	..	15	..	..	..
Ashton-under-Lyne	Mechanics' Institution	Mason, Hugh	Howorth, D. F.	Butterworth, T.	20	20	..	..	3	..	..	..
Bacup	Mechanics' Institution	Aitken, John	Newbigging, T.	{ Shore, T. W. - } { Thornley, Geo. - }	38	51	13	..	2	..	..	..
Banbury	British School	Harrison, W. R.	Cadbury, James	{ Beale, J. H. - } { Owen, A. - }	36	36	..	..	15	..	1 S. 2 B.	..
"	Science School	"	"	Beesley, T.	..	30	30	..	..	..	..	..
"	Laboratory	"	"	Bears, W.	..	10	10	..	..	..	..	..
Barnsley	St. John's School	Hamer, A. G.	Binder, Rev. W.	"	..	17	17	..	25	..	1 B.	..
Birmingham	Midland Institute	Martineau, T.	Smith, Edwin	Woodward, C. J.	122	135	13	..	..	..	..	..
Birmingham	St. Barnabas' National School,	Winter, Rev. S. W.	Bembridge, E.	Bulphitt, M. T.	..	61	61	..	..	..	..	..
"	Metropolitan Railway Works, Salford.	Scovcroft, Rev. J. H.	Smith, David	Bickerton, A. W.	..	..	..	..	..	..	..	..
"	Clarendon Chambers	"	"	"	..	55	55	..	..	..	..	..
"	Westeyan Schools	"	"	"	..	..	..	..	..	..	..	..
"	St. Matthew's Schools, Dud- dleston.	"	"	"	..	..	..	..	..	..	..	..
"	School of Art	Cope, C. R.	Laundy, E.	Raimbach, D. W.	..	53	53	..	..	..	..	..

Blackburn	-	Wesleyan School	-	Beads, Jas.	-	Parkinson, Giles	-	Isherwood, Thos.	-	11	13	2	..	3	..	..
Blandford	-	Mechanics' Institution	-	Hutchinson, R. H.	-	Hand, Thomas	-	Gunn, W.	-	20	16	..	4	..	..	..
Bodmin	-	Working Men's Club	-	Fineham, W. C.	-	Meikle, William	-	Payne, Jas. junr.	-	..	22	..	..	17	..	..
Bolton	-	Literary Institution	-	Stokes, H. S.	-	Phillips, Josias	-	Downing, S.	-	43	47	4	..	..	..	..
"	-	Bridge Street School	-	Cannon, W. W.	-	Marsden, Peter C.	-	Ward, T.	-	65	60	..	5	..	..	..
"	-	Independent Methodists' School.	-	Winterburn, Geo.	-	Vickers, James	-	Collins, John	-	34	13	..	21	9	..	..
"	-	Science and Art School	-	Powell, Rev. Henry	-	Lowe, Rev. J.	-	{ Collins, John Spriggs, Chr. Jomann, Rev. J. G. }	-	31	168	137	..	7	..	..
"	-	Mechanics' Institute	-	Gadon, John	-	Barton, J.	-	Ward, T.	-	95	70	..	16	22	1 G. 3 B.	..
Breage	-	Cornwall	-	Pridmore, Rev. E. M.	-	Cunnack, R. J.	-	{ Spriggs, C. Foster, C. Le Neve }	-	..	12	12	..	..	..	..
Bristol	-	Trade School	-	Moseley, Rev. Canon	-	Wilkinson, J.	-	{ Coomber, T. Plant, E. C. }	-	130	145	15	..	83	1 G., 2 B., 2 B.	..
Bromsgrove	-	Literary and Mechanics' Institute.	-	Collis, F. D.	-	Gibson, C. W.	-	{ Welsh, J. Leipner, A. }	-	..	48	48	..	..	..	..
Burnley	-	Church of England Literary Institute.	-	Parker, Rev. A. T.	-	Briggs, Benjamin W.	-	Dodd, William	-	70	53	..	15	11	..	..
"	-	Carlton Road School	-	Ashworth, Thos.	-	Graham, John	-	Shore, T. W.	-	62	69	7	..	4	..	..
"	-	Westgate School	-	Massey, Lord	-	Massey, J.	-	Clement, Leonard	-	20	12	..	8	2	..	..
"	-	Mechanics' Institution	-	Shuttleworth, Sir J. P. K.	-	Sutherland, J.	-	Shore, T. W.	-	60	48	..	12	10	..	..
"	-	Grammar School	-	Shuttleworth, Sir J. P. K.	-	Sutherland, J.	-	{ Shore, T. W. Wilkinson, T. T. }	-	50	50	..	..	..	..	..
Bury	-	Athenaeum	-	Hildyard, Rev. C. F.	-	Probert, T. W.	-	{ Ward, Thomas Spriggs, C. }	-	60	72	12	..	6	..	..
Canborne	-	British School	-	Smith, George	-	Pike, Walter	-	{ Foster, C. Le Neve Bush, J. }	-	21	31	10	..	4	..	..
Cardiff	-	Free Library	-	Devids, C. W.	-	Price, Peter	-	Notcutt, W. L.	-	56	42	..	14	11	..	..
Cheltenham	-	Bedford Buildings	-	Downing, James	-	Moore, H. J.	-	{ Ewens, Fredk. T. Craister, W. }	-	145	146	1	..	25	1 B.	..
Chester	-	Mechanics' Institution	-	Frost, Meadows	-	Harris, Rev. Jas.	-	Graister, W.	-	64	25	..	30	3	..	..
Chorley	-	National School	-	Stock, Ben. John	-	Paton, Ben. J.	-	Brown, Thomas	-	30	20	20	..	..	..	..
Clitheroe	-	Mechanics' Institution	-	Dayhurst, Robert	-	Mercer, John, jun.	-	Gunn, W.	-	30	12	..	18	6	..	..
Compton	-	Wesleyan Schoolroom	-	Hadfield, W. A. G.	-	Jackson, B.	-	Greenwood, A. T.	-	21	21	..	..	..	..	..
Cottingham	-	National Schoolroom	-	Stuart, Rev. A. G.	-	Miles, Rev. S.	-	Cattell, Thos.	-	14	22	8	..	5	..	..
Croydon	-	Mechanics' Institution	-	Ramsbotham, James	-	Stubbs, Thomas	-	Craister, W.	-	24	15	..	9	8	..	..
"	-	Literary Institution	-	Carpenter, Dr.	-	Price, G. N.	-	{ Jones, T. Sullivan, M. }	-	..	23	23	..	..	..	..
Darlington	-	Science Class	-	Pease, Henry	-	Swinburne, T.	-	{ Weatherhill, Robt. Gunn, W. }	-	..	12	12	..	..	..	..
Darwen	-	Mechanics' Institute	-	Graham, Rev. P.	-	Bradbury, A.	-	Farncomb, E.	-	..	29	29	..	..	..	..
Deplford	-	St. John's School	-	Money, Rev. C. F. S.	-	Earland, Thos.	-	{ Busbridge, W. Dorrell, C. F. }	-	..	18	18	..	..	..	..
"	-	St Paul's School	-	Leves, S. S.	-	Merchant, T. W.	-		-	..	40	40	..	..	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Number of Prizes.		Number of Medals.	
					1894.	1897.		1900.	1897.	1898.	1897.
Denton	Mechanics' Institution	Nicol, Rev. W.	Bailey, F.	Hurst, W.	..	10	10	..	..	..	..
Derby	The Grammar School	Bonals, J.	Longdon, F.	Grewes, C. A.	..	10	10	..	..	..	..
Droylsden	Educational Institution	Ashworth, George	Blackburn, Jas.	Spriggs, C.	60	37	..	33	30	..	..
Eastington	National School	Peters, Rev. Thos.	Hooper, C. H.	Richardson, H.	15	11	..	4	4	..	..
Eastington	Wesleyan Day School	Ford, G.	Warner, E.	Pullen, R.	..	16	16	..	..	..	..
Eastwood	Mechanics' Institute	Wright, F. B.	Plumtree, Rev. H. W.	Fallen, Moses	28	30	..	8	8	..	..
Elland	Mechanics' Institute	Farrar, J.	Kaye, Uriah	Forbes, D. M.	..	..	..	..	..	..	..
Exeter	Literary Society	Head, R. T.	Tucker, J. T.	Jarmain, G.	33	30	..	3	7	..	..
Falmouth	National School	Carne, W.	Hooper, W.	Parke, G. H.	44	37	..	7	7	1 B.	..
Glossop	Mechanics' Institution.	Atkin, Thomas	Wood, Samuel	Sheppard, Wm.	13	14	1	1	1	..	..
Gloucester	Blue-coat School	Washbourn, R.	Fowler, Hugh	Shaw, H. C.	32	10	..	3	1	..	..
Grantham	Science Class	Burbridge, J. F.	Maddison, Rev. G.	Geo, William	45	40	1	..	21	..	..
Greenwich	Literary Institution	Purvis, Prior	Jordan, C. H.	Jeffery, Walter	..	34	34	..	..	..	..
Guisborough	Mechanics' Institution	Chaloner, Thomas	Webster, T.	Cockman, A.	36	50	..	17	..	..	..
Halifax	Working Men's College	Ackroyd, Edward	Gibb, George	Jones, Thomas	25	7	..	18	7	..	..
Hastings	The Institute	Thompson, Rev. E.	Binn, John	Griffiths, J. A.	13	17	3	..	6	1 B.	..
Heywood	Mechanics' Institution	Smith, Mark	Fairbrother, G.	Jarmain, George	39	19	..	10	8	..	..
Huddersfield	Mechanics Institution	Smith, A. M. A.	Rhodes, Geo. W.	Spriggs, C.	33	33	9	..	1	..	..
Hull	Nautical Schools	Whitaker, Thomas	Wilson, Edward S.	Richardson, J. H.	26	10	..	10	4	..	..
Hulme	Working Men's Institute	Aspen, Richard	Lotch, Geo. V.	Scapling, Zebedee	79	78	..	6	96	{ 8 G. } { M. 1 B. }	..
Huntingdon	Walden's School	Ward, W.	Veery, Rev. F. G.	Richardson, H.	11	46	85	..	..	..	..
Hyde	Mechanics' Institute	Hibbert, E.	Lawton, Thomas	James, John	..	30	30	..	..	..	..
Kettering	National School	Lindsey, Rev. H.	Edwards, George	Pasco, John	47	60	18	..	9	..	..
Kingsborough	Science Class	Davis, Rev. J. W.	Thomas, W. J.	Fallowa, J. H.	..	31	31	..	..	..	..
				Sturges, Wm.	..	13	13	..	..	..	..
				Parkhouse, Hy.	..	..	..	..	..	..	..

Kinver	National Schoolroom	Wharton, Rev. G.	Bolton, Thomas	Packer, M. W.	24	34	10	7	..
Lancaster	Mechanics' Institution	Turner, Rev. Canon	Moore, J. D.	Prosser, W.	..	53	53	..	..
Leeds	Mechanics' Institution	Hole, James	Sales, H. H.	Ward, George	33	39	6	11	..
Leicester	St. Martin's School	Vaughan, Rev. D. J.	Jones, H. S.	Atkins, Edward	40	49	9	5	..
"	St. Margaret's School	Fertree, Rev. A.	Fertree, Rev. A.	Poyner, H.	..	5	5	..	..
Lincoln	Grammar School	Ashley, W. T.	Nelson, Rev. H.	Cravley, Samuel	..	21	21	..	..
"	Training College	Mackenzie, Rev. H.	Blenkin, Rev. F. B.	Cravley, Samuel	..	44	44	..	..
"	Mechanics' Institution	Keyworth, J. E. H.	Everard, H.	Cravley, Samuel	..	22	22	..	..
Liverpool	Free Library	Samuell, E. S.	Gregson, S. L.	Birkenhead, E. H.	28	68	40	9	1 S.
Liverpool	Liverpool Institute	Samuell, C. S.	Sharpe, Charles	Adair, S.	..	90	90	..	..
Liverpool	Copper Works School	Nevill, C. W.	Davies, John	Jones, John	33	49	17	9	..
London	City Middle-class School	Wormell, Rich.	Wormell, Rich.	Davidson, E. A.	..	24	24	..	..
Bethnal Green	Sir Walter St. John's School	Bryant, W. J. D.	Bryant, W. J. D.	Martin, J.	..	63	63	..	..
"	Birkbeck Schools	Rintz, George	Rintz, George	Snelus, G. J.	119	130	11	16	..
"	National School	Halliday, J.	Halliday, J.	Pike, Robert W.	29	53	23	13	2 G. 18.
Chelsea	St. Mark's Practising School	Mayo, Rev. M. W.	Benham, Rev. W.	Simpson, B.	..	..	..	..	..
St. Ormonds Street	Working Men's College	Maurice, Rev. F. D.	Rawlins, Hy. E.	Dave, C. S.	64	124	60	38	..
Islington	Lower Islington Public School	Fleming, Rev. W.	Ross, John	Lawson, W.	7	18	11	25	2 G.
Kingland	Kingsland and Dalston Institute	Aveling, Rev. T. W.	Hoskins, W. H.	Atkins, G.	104	109	5	5	1 B.
Lambeth	Boy's Schoolroom, Lambeth Green	Scaton, Rev. W.	Heller, T. E.	Briggs, H.	45	36	..	9	..
Leadenhall St.	City of London College	Whittington, Rev. B.	Maskell, Rev. J.	Jones, J.	26	39	13	7	..
Polytechnic	Royal Polytechnic Institution	Mackenzie, Rev. C.	Cousens, J.	Griffiths, J. A.	22	34	12	3	..
Chancery Lane	London Mechanics Institution	Campbell, Hon. D.	Parry, H.	Gibson, Rev. B. W.	33	47	15	21	..
Dock Street	Sailors' Home	Maude, Francis	Webb, W. H.	Coles, F. J.	17	10	..	7	..
Pecham	Upper and Middle Schools	Gray, E. A.	Hutchinson, T.	Tate, E.	..	256	256	..	..
Macclesfield	Modern Free School	Wardle, Thomas	Brooker, J.	Jackson, J.	38	348	348	3	..
Manchester	Oldham Road National School	Lindsay, Rev. T.	Gregory, John	Holt, Joseph	28	36	..	28	..
Manchester	Roby Educational Society's Rooms	Callender, W. E.	Ellis, E. P.	Schofield, J.	13	31	18	1	..
"	Mechanics' Institution	Neill, Robert	Jarrett, Albert	Angell, J.	388	239	..	149	2 S. 2 B.
"	"	"	"	Mellor, J.	..	..	..	..	..
"	"	"	"	Tomkins, E.	..	..	..	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1886.	1887.			1886.	1887.	1886.	1887.
Manchester - <i>Middlesborough</i>	Corporation Street - <i>Church of England Institute</i>	Smith, Rev. A. C.	Plant, John <i>Donaldson, Rev.</i> <i>A. B.</i>	Lightbown, J. H. <i>Stead, W.</i>	42	36	..	6	5	..	1 B.	..
Middlesborough	Mechanics' Institution	Gilkes, Edgar	Taylor, Wm.	Weatherill, R.	..	6	..	..	..	..	..	..
Middleton	National School	Durnford, Rev. R.	Taylor, Wm.	Wheeler, G. H.	9	8	..	1	..	..	1 G.	..
Nelson-in-Marsden	Lomeshaye Mills	Eccroyd, W.	Waddington, J.	Clement, J.	17	22	..	5	..	..	..	..
Newport (Mon.)	Athenaeum and Mechanics' Institution.	Graham, W., Jun.	Maynard, E.	Bush, James	36	27	..	9	13	..	..	..
Newton Heath	<i>Church Street</i>	<i>Taylor, Joshua</i>	<i>Beams, George</i>	<i>Lightbown, J. H.</i>	23	16	..	7	4	..	..	..
North Ormsby	Mechanics' Institution	Taylor, Joshua	Holt, Samuel	Jones, Thomas	..	10	..	10	..	..	..	..
Nottingham	Church Institute	Pennyman, J. S.	Moyle, Rev. V. H.	Weatherill, Robert	16	12	..	4	3	..	..	..
Nottingham	Mechanics' Institution	Morse, Rev. F.	Thurlof, Richard	Simpson, A.	10	7	..	3	2	..	..	..
Oldham	<i>Glodwick Mutual Improve-</i> <i>ment Society's Room.</i>	<i>Robinson, John</i>	<i>Green, Jeremiah</i>	<i>Sissling, W.</i>	75	85	..	40	19	..	..	..
"	Science and Art School	Platt, John	Bailey, Thomas	<i>Kershaw, T. Jun.</i>	..	80	..	80	..	..	..	..
"	Parish Church School	Schofield, James	Walters, Rev. W.	<i>Mitchell, Thomas</i>	100	100	..	..	36	..	1 G. 1 S.	..
"	Analytical Society	Fox, Rev. J. H.	Nuttall, William	<i>Bahin, C. P.</i>	..	19	..	19	..	..	..	..
Padiham	National School	Gardner, W.	Warburton, Rev. P.	<i>Mellor, James</i>	13	14	..	1	..	..	..	..
Painwick	Free School	Waterhouse, J.	Harrop, J.	<i>Taylor, William</i>	..	18	..	18	..	..	..	..
Pendleton	Mechanics' Institution	<i>Armitage, B. Jun.</i>	<i>Armitage, B.</i>	<i>Shore, T. W.</i>	12	10	..	2	15	..	..	..
Pendleton	<i>Pendleton Club</i>	McAlister, J. A.	Hammond, J.	<i>Rowden, W. T.</i>	17	17	..	..	2	..	..	..
Plumstead	Burrage Road School	Rick, Rev. J. E.	Widlake, T. H.	<i>Farlie, C. J.</i>	..	35	..	35	..	..	..	..
Plymouth	28, Bucknell Street	Radford, W.	Cawse, J. H. M.	<i>Shipman, C.</i>	57	62	..	5	46	..	1 B.	..
Plymouth	Science School	Hill, Richard	Cumming, W. B.	<i>Hearder, J. N.</i>	..	18	..	18	..	..	..	..
Pontypridd	Navigation School	Williams, D. W.	Bassett, C.	<i>Hingston, A.</i>	124	154	..	30	31	..	1 S. 1 B.	..
Portland	<i>The Grove School</i>	Jackson, C. R.	Dunn, James	<i>Rider, A. J.</i>	..	17	..	17	..	..	..	..
Preston	School of Science	Tamplin, Rev. G. F.	Larkin, Charles	<i>Merrifield, J.</i>	..	15	..	15	..	..	..	..
Purleigh	Science Class	Durnford, Rev. R.	Corbould, Rev. W. H.	<i>Robotham, W.</i>	23	37	..	14	7	..	..	..
Rhodes	National School	..	..	<i>Moffat, Wm.</i>	20	23	..	8	7	..	..	..
Rhodes	..	..	..	<i>Giffin, Robert.</i>	..	28	..	23	..	..	..	..
Rhodes	..	..	..	<i>Wheeler, G. H.</i>	..	23	..	23	..	..	..	..

St. Helen's	St. Thomas's School -	Menzies, W. J. -	Bournes, Thomas -	19	22	3	3	..	..
St. Just -	The Institution	Boyns, R. -	Foster, C. Le Neve -	25	17	..	8	..	4
Salford -	Working Men's College	Plant, John	Almull, T. -	44	18	..	9	9	..
Salford -	St. John's Hall	Richardson, G. -	Lav, E. -	20	..	..	..	..	..
Slough -	Mechanics' Institution	Chapman, J. -	Tomkins, E. -	65	65	..	3	..	..
Selling -	Wesleyan School	Brown, F. -	Dorrell, J. -	19	..	..	19	..	..
Stockport -	Mechanics' Institution	Leigh, William	Smithies, S. -	39	31	..	8	13	1 B.
Stonehouse	The Institution	White, Rev. W. F. -	Gee, W. -	10	21	..	11	2	..
Stroud -	Stroud Institute	Dickinson, S. -	Vick, W. -	63	45	..	18	12	1 S., 1 B.
Telworth -	Wesleyan Day School	Gardner, H. F. -	Pullen, M. -	13	70	..	19	12	1 B.
Torquay -	School of Science and Art	Gurney, N. -	Vick, W. -	36	34	..	34	12	..
Torquay -	1, Spring Cottage	Strong, C. E. -	Macrell, I. -	18	30	..	18	1	..
Walsall -	Science School	Moyse, Charles	Praet, W. N. -	31	37	..	1	3	1 B.
Wigan -	Mining and Mech. School	Irvine, Rev. A. C. -	Packer, M. W. -	30	30	..	7	3	..
Wolverhampton	Athenaeum Class	Fergie, Rev. T. F. -	Birkenhead, E. H. -	12	..	..	12	..	..
Wolverton -	Science and Art Institution	Iles, Rev. J. H. -	Packer, M. W. -	60	50	..	10	29	..
Woolwich -	{ Mechanics' Institution, }	Mumford, A. L. -	Harrett, Rev. F. W. -	62	..	..	2	28	..
"	{ Royal Arsenal. }	Anderson, John	Burgess, Rev. S. -	58	..	..	34	5	1 S.
Woolwich -	National School	Brown, Rev. H. -	Stone, W. -	65	..	..	65	..	..
Woolwich -	St. Thomas' Parochial School	{ Robertson, Capt. }	Duckett, W. -	112	189	..	27	5	..
Yarmouth, Great	Navigation School	R., E. N. -	Davidson, G. -	94	94	..	26	9	..
York -	Popular Institution	Nuall, H. R. -	Jones, E. S. L. -	..	..	..	..	..	..
		Palmer, Rev. H. V. -	Brown, L. -	..	..	..	..	..	..
			Noble, John -	..	..	..	..	..	..
			Rowden, W. T. -	..	..	..	..	..	..
			Bushbridge, W. -	..	..	..	..	..	..
			Clark, John J. -	..	..	..	..	..	..
			Stockton, W. -	..	..	..	..	..	..
			Hewison, Rev. G. H. -	..	..	..	..	..	..
			Ripley, H. -	..	..	..	..	..	..
			Browne, J. -	..	..	..	..	..	..

SCOTLAND.

Aberdeen -	Mechanics' Institution	Sinclair, J. -	Beveridge, Dr. -	6	91	23	6	..	..
"	Navigation School	Kellas, J. F. -	Maver, D. -	254	..	..	..	..	..
Corsock -	Girls' School -	Houston, S. -	Ritchie, George -	13	..	..	9	..	..
Dundee -	High School -	Cumming, A. W. -	Macomish, M. -	57	62	5	11	..	..
			Kennedy, John -	..	..	..	..	..	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1894.	1897.			1894.	1897.	1894.	1897.
Glasgow	Secular School	The Lord Provost.	Cunliffe, Rich. S. Lang, Gilbert	Mayer, J. { Mayer, Mrs. MoRae, J. Lochove, J.	103	103	..	9	44	..	1 B.	..
Inverness	Andersonian University	Dallas, W.	Galloway, G.	Bain, Robt. J.	..	327	327	..	..	..	1 B.	..
Kilmarnock	New Public School	Aitken, Rev. James	MacKay, John	{ Storemoun, James Dunn, H. S.	26	43	23	..	1	..	..	..
Leith	Navigation School	Paton, Walter	Thomson, Rev. J.	Bolau, J.	313	300	..	13	..	..	..	..
IRELAND.												
Antrim	Science Class	Ferrard, M.	Wilson, D. M.	Savage, H.	..	43	43	..	..	..	..	..
Armagh	{ Natural History Society's House	Brown, S.	Davidson, B. P.	Mills, L. G.	19	31	9	..	10	..	..	..
Athlone	St. Mary's Schools	Handcock, R.	Berry, Rev. E. F.	James, M. H.	..	38	38	..	..	..	..	..
Baltimore	Model National School	Dalton, G. T.	Simpson, A. J.	Doherty, J. J.	..	86	86	..	..	..	..	..
Ballycarry	Science Class	Dakay, M. E.	Smiley, Alast.	McGuffin, Robt.	..	7	7	..	..	..	..	..
Ballymena	National School	Moore, Rev. S. J.	Lynch, Rev. J.	McCormick, J.	..	14	14	..	..	..	..	..
Ballymena	Model School	Rowan, Rev. R. W.	Given, John	Shannon, A. F.	30	38	8	..	..	..	..	..
Banbridge	National School	Rowan, Rev. R. W.	Lynch, Rev. John	Black, E.	..	18	18	..	13	..	..	..
Belfast	{ Scarva Street National Sch. School	Anderson, Rev. E.	Noble, John	Gillespie, Jas.	..	38	38	..	..	..	..	..
Belfast	{ Belfast Academy, Donegal Street	Mullan, W.	Shepherd, W.	Broome, W. M.	..	13	13	..	..	..	..	..
Belfast	{ Fishwick Place Na- tional School	Lytle, John	Nesbitt, E.	McNeill, James	13	80	67	..	5	..	..	..
Belfast	{ Linen Hall Street Model School	Mullan, W.	Shepherd, W.	Cleland, Robt.	..	23	23	..	..	..	..	..
Belfast	{ Stanhope Street National School	Mullan, W.	Shepherd, W.	Brown, W. M.	16	47	31	..	..	..	..	..
Belfast	Great George Street	Lytle, John	Shepherd, W.	Smeth, Rowland	23	33	13	..	14	..	..	..
Belfast	Crumlin Road	Lytle, John	Shepherd, W.	MacMillan, W.	..	30	30	..	..	..	..	..
Belfast	Old Lodge Road	Lytle, John	Nesbitt, R.	{ Meera, Stevenson and Barklie.	33	63	30	..	11	..	1 B.	..
Belfast	Academy Street	Lytle, John	Nesbitt, E.	Barklie, R.	..	23	23	..	..	..	..	..
Belfast	..	..	Nesbitt, E.	Millar, J. B.	..	16	16	..	..	..	..	..
Belfast	..	..	..	Gray, T.	..	20	20	..	..	..	..	..
Belfast	..	..	..	McGee, Dr.	..	19	19	..	..	..	..	..
Belfast	Royal Academical Institute	Mullan, W.	Shepherd, W.	Hunter, J.	64	45	..	19	15	..	1 G.	..

TABLE showing the CLASSES in each of the preceding SCIENCE SCHOOLS, the SUBJECTS taught, and the NUMBER of STUDENTS in each Subject.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
			Practical, Plane, and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economic Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Abingdon	British School-room	25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Accrington	Mechanics' Institution	21	14	14	..	..	..	..	..	..	10	21	..	..	..	..	..	..	..	..	..	..	..	..	..
Alderley Edge	Day School-room	14	14	14	..	..	..	..	..	..	..	22	..	..	..	..	..	..	..	..	..	..	..	..	..
Almondsbury	King James's Grammar School.	22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Andover	Mechanics' Institution	47	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arwick	Wesleyan School	10	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ashby-de-la-Zouch	Mutual Improvement Society's Rooms.	36	..	..	..	..	..	..	..	..	..	36	..	..	..	..	..	7	..	..	..	..	..	..	..
Ashton-under-Lyne	Mechanics' Institution	15	15	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bacup	Mechanics' Institution	49	..	..	..	..	..	..	..	..	..	13	..	..	..	..	..	..	..	..	..	..	..	..	..
Banbury	Brian School.	30	..	..	..	..	..	..	..	10	..	..	..	..	..	..	20	20	..	..	..	..	..	..	..
"	Science School.	30	..	..	..	..	..	..	..	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Laboratory	8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Barnsley	St. John's School	12	12	..	..	..	..	..	..	4	..	101	..	..	..	..	..	..	..	..	..	..	..	..	..
Birmingham	Midland Institute	108	..	..	..	..	..	..	..	19	19	10	..	..	..	..	..	..	..	..	..	..	..	..	..
"	St. Barnabas' National School.	45	..	..	..	..	..	..	..	..	..	10	..	..	..	..	31	9	..	..	..	..	..	..	..
"	Railway Works, Saltley.	59	53	..	..	..	..	..	..	..	51	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Wesleyan Schools, St. Matthew's Schools, Duddeston, Clarendon Chambers.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Blackburn	School of Art.	55	..	55	..	..	..	..	..	..	..	9	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Wesleyan School.	9	..	..	..	..	..	..	..	..	12	15	..	..	..	..	6	..	..	..	..	..	..	..	..
"	Mechanics' Institution	18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

ENGLAND.

Table showing the Classes in each of the preceding Science Schools, &c.—continued.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	II.	Building Construction.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Glossop	Littlmore and Howardtown Mechanics' Institute	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gloucester	Blue-coat School	44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Grantham	Science Class	24	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Greenwich	Literary Institution	47	47	47	47	47	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Guisborough	Mechanics' Institution	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Halifax	Working Men's College	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Haarlingen	The Institute	18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heywood	Mechanics' Institution	32	20	20	20	30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Huddersfield	Mechanics' Institution	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hull	Nautical Schools	73	..	..	..	..	70	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hulme	Working Men's Institute	43	17	17	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Huntingdon	Walden's School	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hyde	Mechanics' Institution	57	12	37	37	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kettering	National School	18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kingsbridge	Science Class	14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Kinver	National Schoolroom	30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lancaster	Mechanics' Institution	56	..	..	..	..	22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leeds	Mechanics' Institution	31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leicester	St. Martin's School	41	..	..	..	..	18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	St. Margaret's School	4	..	..	..	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lincoln	Grammar School	23	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Mechanics' Institution	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Training College	44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Free Library	68	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Liverpool	Liverpool Institute	90	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table showing the Classes in each of the preceding Science Schools, &c.—continued.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
			Practical, Plane, and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economic Botany.	Systematic Botany.	Mining.	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Padiham	National School	17	..	..	..	..	..	..	..	17	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Painewick	Free School	10	16	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pendleton	Mechanics' Institution	15	16	16	..	..	..	..	..	35	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Pendleton Club	35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Plumstead	Burrage Road School	60	60	60	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Plymouth	28, Buckwell Street	17	..	..	..	..	..	..	..	43	7	11	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Science School	153	34	..	..	..	..	..	..	..	3	8	..	16	..	..	..	..	..	..	..	..	..	..	..
Pontypridd	The Grove School	99	..	..	..	..	..	..	..	14	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Portland	The School	14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Preston	Avenham Institute	36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Purleigh	School-room	27	..	..	..	..	..	..	..	27	27	31	..	..	..	..	..	..	..	..	..	..	..	..	..
Rhodes	National School	22	..	..	..	..	..	..	..	..	..	22	..	..	..	..	..	..	..	..	..	..	..	..	..
St. Helen's	St. Thomas' School	16	..	..	..	..	..	..	..	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..
St. Just	The Institution	25	..	..	..	..	..	..	..	..	..	25	..	..	..	..	..	..	..	..	..	..	..	..	..
Salford	Working Men's College	50	10	10	..	..	..	..	..	6	6	30	30	6	..	..	..	..	..	..	..	..	..	..	..
"	St. John's Hall	15	15	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sibford	Friends' School	11	52	..	..	..	..	..	..	..	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..
Slough	Mechanics' Institution	52	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stillington	Wesleyan School	19	..	..	..	..	..	..	..	..	..	19	..	..	..	..	..	..	..	..	..	..	..	..	..
Stockport	Mechanics' Institution	37	10	15	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stonehouse	The Institute	11	..	..	..	..	..	..	..	..	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..
Stroud	Stroud Institution	59	..	..	..	12	..	..	..	..	12	31	..	..	..	..	..	..	..	..	..	..	..	..	..
Teworth	Wesleyan Day School	12	..	..	..	..	..	..	..	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Torquay	School of Science and Art	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	1, Spring Cottages	21	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

**Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[6351.—500.—8/67.]**

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF COUNCIL ON EDUCATION,
SOUTH KENSINGTON.

DIRECTORY,

(Revised to November 1867.)

16th EDITION.

WITH

REGULATIONS

FOR

ESTABLISHING AND CONDUCTING

SCIENCE SCHOOLS & CLASSES.

THE RULES IN THE PRESENT EDITION SUPERSEDE THOSE IN ALL FORMER EDITIONS,
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LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

SOLD BY CHAPMAN AND HALL,
193 PICCADILLY, LONDON.

1867.

Price Sixpence.

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Instructor in Engineering Drawing.—John Maxton.

Instructor in Marine Engineering.—J. F. Cotterell.

Instructor in Practical Chemistry.—John Davidson.

Instructor in French.—M. Penon.

SUMMARY of the NATURE and AMOUNT of ASSISTANCE
afforded by the SCIENCE AND ART DEPARTMENT to
the INDUSTRIAL CLASSES in procuring INSTRUCTION
in SCIENCE.

*[Important Alterations made since the last edition of the Directory are
printed in Italics.]*

I. A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

II. This sum is administered by the Science and Art Department.

III. The head of the Education Department, of which the Science and Art Department is a branch, is the Lord President of the Council, assisted by a member of the Privy Council, who is called the Vice-President of the Committee on Education, and who acts under the direction of the Lord President, and for him in his absence. (Order in Council, 25th February 1856, Act 19 & 20 Vict. c. 116.)

IV. The object of the grant is to promote instruction in Science especially among the industrial classes,* by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.†

V. The payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though

Payment of
Fees by
Students.

* Direct payments are made to teachers only on behalf of adult *artisans*, or the children of artisans, or the children of persons who are not assessed to the income tax, that is, who do not possess an income of 100*l.* a year. (See § xviii.)

† The amount is liable to be decreased and eventually withdrawn. Payments to teachers therefore must not be looked upon as perpetual, or in any way conferring on the teacher a claim to any payments beyond those offered for each current year.

my Lords do not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, Committees of schools and classes and teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also on artisans.

VI. The following are the Sciences towards instruction in which aid is given :—

Subject 1, Practical Plane and Solid Geometry.

„ 2, Machine Construction and Drawing.

„ 3, Building Construction *or* Naval Architecture and Drawing.

„ 4, Elementary Mathematics.

„ 5, Higher Mathematics.

„ 6, Theoretical Mechanics.

„ 7, Applied Mechanics.

„ 8, Acoustics, Light, and Heat.

„ 9, Magnetism and Electricity.

„ 10, Inorganic Chemistry.

„ 11, Organic Chemistry.

„ 12, Geology.

„ 13, Mineralogy.

„ 14, Animal Physiology.

„ 15, Zoology.

„ 16, Vegetable Physiology and Economic Botany.

„ 17, Systematic Botany.

„ 18, Mining.

„ 19, Metallurgy.

„ 20, Navigation.

„ 21, Nautical Astronomy.

„ 22, Steam.

„ 23, Physical Geography.

VII. The assistance granted by the Science and Art Department is in the form of—

1. Payments on results to teachers. (See § viii., xv., xviii. to xx.)
2. Grants towards the purchase of apparatus, &c. (See § xxii.)
3. Public examinations in which Queen's Medals and Queen's Prizes are awarded, held at all places complying with certain conditions. (See § xi. to xvii.) On the results of these examinations the payments are made to the teachers. (See § xv., xviii., and xix.)

VIII. Persons are qualified to earn payments on results who have:—

a. obtained certificates as teachers in any of the before-mentioned sciences at the examinations for teachers of the Science and Art Department held previous to January 1867, or,

b. after the abolition of the above examinations—February 1867—obtained a First or Second Class at the examination* specified in § xi.

No payments are made to a teacher on account of instruction given in subjects in which he is not so qualified.

IX. Suitable premises, with firing, light-^{School Premises.} ing, &c., must be found and maintained at the cost of the locality where the school or class is held. If at any time the funds do not cover these requisite local expenses, it must be inferred that there is no such demand as the Government is justified in aiding, for instruction in the locality; and the assistance of the Department will be withdrawn.

X. A Local Committee of not less^{Local Committee.} than five well known responsible persons must be formed in connexion with every Science

* Such examination will be dispensed with in the case of a candidate who has taken a degree at any University of the United Kingdom, or who has obtained the Associateship of the Royal School of Mines, London, or the Royal College of Science, Ireland. Full particulars must be furnished by the applicant, and his diploma sent for inspection.

Class, who will carry out the instructions contained in the Appendix.* (See pages 14 and 18 to 22.)

Examination
of Classes.

XI. The Science and Art Department holds annually in May (see Science Form, No. 232, page 59*), through the agency of the Local Committees, a public examination of all Science schools and classes, whether taught by teachers qualified as above or not, in any place in the United Kingdom which complies with the requisite conditions. (See § x., xiii., and xiv.) On the results of this examination the payments are made to qualified teachers. (See § xv. and xviii.) Application for it must be made before the end of March in each year, stating the number of persons and the subject or subjects in which they are to be examined. The form of application, Science Form No. 119 (see page 22*), will be sent on application to the Secretary, Science and Art Department.

In addition to the above, examinations in Mathematics, Navigation, Nautical Astronomy, Steam, and Physical Geography are held for the benefit of seafaring men—and for them only—three times a year in all seaports where Local Committees are formed and are willing to undertake them. These examinations take place in the beginning of March, September, and December. The application for these examinations must be made on Science Form No. 119 before the 10th day of the previous month.

If at any time there be reason to suspect the fairness of the examination generally, or of the way in which particular candidates have worked their papers, a further examination will take place in such manner as may be deemed most advisable. Refusal on the part of any candidate to answer will entail the cancelling of his previous examination.

Examination
of Classes.

XII. A school or class taught by a teacher not qualified to earn payments as above, may, by applying to the Secretary of the Science and Art Department, be examined at the

* Science Directory.

same time and in the same manner as the classes under qualified teachers: provided that a Local Committee be formed which complies with the requisite conditions. (See Appendix, page 21,* Science Form, No. 88 a.)

If the class be for artisans the pupils are eligible to receive Queen's Prizes and Queen's Medals under the same condition as the pupils of qualified teachers. Should it however be for the middle classes the pupils are not eligible for prizes and medals, but receive certificates of merit instead.

XIII. If two or more classes in the same ^{Places of Examination.} town, or within a reasonable distance of one another, apply for the examination of the Science and Art Department, a general examination committee must be formed by the amalgamation of the several Committees to carry out the examinations at some common centre, such as the town hall or other public building. It is only when the classes consist of 50 or more candidates that such amalgamation of the committees will not at present be insisted on.

XIV. Any persons whatever, whether ^{Examination of other Students.} taught by the qualified teacher or not, may present themselves at the Local Committee's examination on registering their names in time for the Local Committee to comply with the instructions, and paying a registration fee of not more than 2s. 6d. each. Arrangements must therefore be made by the Local Committee, or the General Examination Committee, as the case may be, to enable other candidates, besides the students in the class for which the Committee act, to present themselves at this examination. The registration fee of 2s. 6d., which such candidates may be required to pay, is to reimburse the Committee for any extra expenses incurred by such attendance, and may at their option be remitted.

XV. The successful candidates at the ^{Classification of Results.} May examination and the quarterly examinations of seamen are classified under the heads

* Science Directory.

of first, second, third, fourth, and *fifth* class. The standard of attainment required may be raised from year to year. For the *fifth* class it is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. Those who have attained a higher degree of proficiency are classed as 4th, 3rd, 2nd, or 1st class, according to their merit.

Queen's
Prizes.

XVI. To the 1st, 2nd, and 3rd class are given Queen's prizes consisting of books or instruments chosen by the candidates from lists furnished for that purpose. These are unlimited in number, and are open to all candidates who come within either of the following categories, (1) Students in Science Classes under qualified Teachers; (2) Registered Students in Artisan Classes taught by any Teachers, or (3) *bonâ fide* Artisans.

Other candidates, if successful, receive instead Cards of merit recording their success.

The following are exceptions to the above rule:—

a. Teachers earning or who have earned payments on the results of instruction; and

b. Students who have previously received the same, or a higher class, in the same subject.

—the names of such candidates will simply be recorded in the published lists.

Queen's
Medals.

XVII. To the four best in each subject are awarded Queen's medals. These consist of one gold, one silver, and two bronze in each subject for competition throughout the United Kingdom. They are only awarded if there are a sufficient number of qualified candidates, and the gold medal will only be given in cases of high merit specially recommended by the examiner. The same candidate cannot obtain the same medal in the same subject more than once.

Only registered students of schools and classes under Local Committees (see § x. and xii.) are eligible for medals. They cannot be taken by middle class students who are more than 17 years of age or by teachers who are earning or have earned

payments on the results of instruction. Students who but for this restriction would have taken the medal, will receive an honorary certificate instead. Should a student take more than one gold, silver, or bronze medal, he will receive books instead of a second medal.

XVIII. Payments are made to the ^{Payments to Teachers.} teacher qualified as in § viii. on account of the instruction of students of the Artisan Classes (for definition of Artisan Class *see* Science Form No. 51, page 23) in the manner specified below:—provided that the student has received 25 lessons* at least from the teacher in each subject in which he claims payment since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate evening. The 25 lessons need not necessarily be all given in one year, but may extend over a longer period.

XIX. 1*l.*, 2*l.*, 3*l.*, 4*l.*, 5*l.* are the claimable payments for each student in each subject, according to the class in which he passes, but these amounts may be reduced in the following ways:

1st. If the student has been previously successful in the same subject, such payments are reduced by the normal payment which was claimable on such previous success; for instance, the 4*l.* payment for a second class would, if the student had previously taken a fourth class, be reduced by 2*l.*†

2nd. If a student be successful in more than one subject at an examination, the payments on account of such further subjects are reduced by one half.

* It must be clearly understood that the number (25) of lessons which the teacher is required to give is the minimum fixed as a criterion that the pupil has received his instruction from the teacher. It is not meant in any way to specify that that amount of instruction is sufficient, or to guarantee the teacher's receiving payment, if that amount of instruction alone is given.

† Deductions will be made in payments on account of Subject I. to the amount of any payments that have been made on Second Grade Examinations in Art, in practical geometry, perspective or mechanical drawing.

3rd. When on this scale they would amount to more than 60%. the excess up to 40% is diminished by one quarter, the excess above 40% by one half. Thus payments which on the above scale would be 100% and 150% will be reduced to 90% and 115% respectively. * If the teacher be instructing classes three miles or more apart this deduction will be reduced by the amount of his travelling expenses.

Form of Claim
for Payment.

XX. The claim of a teacher for the payments under these several heads is made on Science Form, No. 51, which will be sent on application. The voucher must be signed by the secretary and two members of the Committee of the Science Class or School; or by at least three of the Committee. (See Appendix, page 23.)

School
Register.

XXI. A school register must be kept in each subject on a Form which will be supplied on application. This must be made up from day to day, and will be examined and approved by the Inspector on his visit. It must be sent to the Department with the teacher's claim for payment, and no payment can be made unless it is properly kept.

Grants for
Apparatus.

XXII. A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent. on the cost of them, is made to Science Schools and Classes in Mechanics' and similar institutions with a properly constituted Committee (see § x.) A requisition must in these cases be made on Science Form No. 49. (See page 29.)

Instruction in
an Elementary
School.

XXIII. All payments to qualified teachers on account of Science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect of any instruction in Science that may be given

* Thus, 100, that is $60 + 40$, is reduced to $60 + 40 - \frac{1}{4}$ of 40 = $60 + 30 = 90$. 150, that is, $60 + 40 + 50$ is reduced to $60 + 30 + 25 = 115$.

during the three attendances of an Elementary School receiving aid from the Education Department, Whitehall.

Use of
Elementary
School
Premises.

XXIV. These grants are only made while the teacher is giving instruction in a day or evening school or class for the industrial classes (adults or boys), approved by the Science and Art Department, and open at any time to the visit and inspection of its officers. The Managers of an Elementary School under the inspection of the Education Department can permit their premises to be used for Science teaching, provided that no interference be allowed with the primary purposes of such Elementary School, or in any way with the three attendances of the Elementary School.

N.B.—On the next page will be found a table of memoranda for the use of Secretaries and Members of Science Committees (Science Form, No. 170) which it is expected will be carefully attended to. This, as well as the other Forms given in the Directory, can be had on application to the Secretary, Science and Art Department.

* * * *The Directory for Science Schools and Classes is sold by Messrs. Chapman and Hall, 193, Piccadilly, London, or may be obtained from the Secretary, Science and Art Department, by enclosing six postage stamps.*

APPENDIX.

SCIENCE FORM, No. 170.

MEMORANDA FOR THE USE OF SECRETARIES AND
MEMBERS OF SCIENCE COMMITTEES.

Dates.

Immediately on the re-assembling of the class after the summer vacation.	Formation of Committee, Form No. 88. Or continuation of Committee, Form No. 168.
Constantly - - -	To carefully fill in and send to the Department Form No. 120.
	To visit the School and see that the Register is kept from day to day, and that everything is regular.
Before 31st March	To send Form No. 119 applying for examination in May.
Before 24th April -	To see that Form No. 91 is hung up in the School-room.
On the 27th April	If a parcel containing (1) the papers for the candidates to work upon, (2) copies of Form No. 91, one for each day's examination, and (3) envelopes in which to return the worked papers, should not have been received, or if there should be any mistake in the numbers sent for each subject as applied for, or in the covering letter, to communicate <i>at once</i> to the Department.
During the May examinations.	The examination papers for each evening will leave London by the night mail two evenings before, i.e., Thursday evening papers will leave on Tuesday evening, Friday's on Wednesday evening, etc. Should they not arrive accordingly, a telegram to be sent <i>at once</i> to the Department.
On the evening of examination.	The candidates, being all seated at 6.50, to read out the rules on Form No. 91, then give out the papers to be worked on. Then at 6.55 to break the seal of the examination papers and distribute to the candidates. To adhere rigidly to the rules on Form No. 91. To sign Form No. 91. To seal up the papers in one of the envelopes provided and at once post them.
After the May examinations.	On receiving lists of the results to give one copy to each candidate whose name appears in it as being successful; to inform the others they have failed.
	To return Form No. 161 filled up as soon as possible in strict accordance with the rules on Form No. 110. (Prize List). To return Form No. 244a. To examine and certify Teacher's claims for payment, Form No. 51, and the School Register, which must be sent up at the same time. To return Form No. 108.
	To keep a record of, and inform the Department of the number of individuals examined.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL SCHOOL OF MINES, LONDON.

ROYAL EXHIBITIONS.

1. There are eight Royal Exhibitions to the Royal School of Mines, Jermyn Street, of the value of 50*l.* per annum, entitling the holders to free admissions to all the lectures, and to the Chemical and Metallurgical Laboratories at the Royal School of Mines, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the School.

At the May 1868 examination three of the above Royal Exhibitions will be open for competition independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans, and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May examination (see Science Directory), viz.:—

To a 1st grade in any subject	-	-	-	-	9 marks.
To a 2nd " "	-	-	-	-	7 "
To a 3rd " "	-	-	-	-	5 "
To a 4th " "	-	-	-	-	3 "
To a 5th " "	-	-	-	-	1 "

and in addition—

For a gold medal	"	-	-	-	10 "
For a silver medal	"	-	-	-	7 "
For a bronze medal	"	-	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object, they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal School of Mines, Jermyn Street, are granted to any person who takes a gold medal in the May examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

EXHIBITIONS AND FREE ADMISSIONS AT THE ROYAL COLLEGE OF SCIENCE, DUBLIN.

ROYAL EXHIBITIONS.

1. There are nine Royal Exhibitions to the Government School of Science, Dublin, of the value of 50*l.* per annum, entitling the holders to free admission to all the lectures and to the chemical and metallurgical laboratories at the Royal College of Science, Dublin, to be held from year to year for three years, on the condition that the holder attends the lectures regularly during those years, and passes the examinations required for the associateship of the college.

At the May 1868 Examination three of the above Royal Exhibitions will be open for competition, independently of the prizes, &c. offered by the Science and Art Department.

All persons over 21 years of age, excepting artisans and such as come within the category of persons paid upon under the Science Directory, will be excluded from competing for the Royal Exhibitions. Special cases, however, must be determined according to the spirit of the rules, and the object of the endowment.

The competition for the Royal Exhibitions will be determined by affixing the following values to the several results of the May Examination (see Science Directory), viz. :—

To a 1st grade in any subject -	-	-	9 marks.
To a 2nd " " -	-	-	7 "
To a 3rd " " -	-	-	5 "
To a 4th " " -	-	-	3 "
To a 5th " " -	-	-	1 "

and in addition—

For a gold medal, " -	-	-	10 "
For a silver medal " -	-	-	7 "
For a bronze medal, " -	-	-	5 "

N.B.—Science Certificated Teachers may compete for the Royal Exhibitions. When coming up simply with this object they should inform the Science and Art Department, so that their names may not appear in the published list with the students.

FREE ADMISSIONS.

2. Free admissions to the lectures at the Royal College of Science, Dublin, are granted to any person who takes a gold medal in the May Examination.

But no candidate will be allowed to take a Scholarship who has not obtained at least a 3rd class in Elementary Mathematics.

FORM OF APPLICATION for the ROYAL EXHIBITIONS to the ROYAL SCHOOL OF MINES, Jermyn Street, London, and the ROYAL COLLEGE OF SCIENCE, Dublin.

The following candidates at the recent May Examinations are candidates for the Royal Exhibitions at the* _____

and they are either—

1. Under 21 years of age.
 2. Or artisans or operatives in the receipt of weekly wages, supporting themselves by their own manual labour, or their children not earning their own livelihood.
 3. Or, although not artisans, yet such as may fairly be considered as belonging to the industrial classes, as coming within one of the following categories, or being the children of such.
 - a. Though paid at longer intervals than a week, still supporting himself by his own manual labour and not by profit on the labour of others, that is, not employing apprentices, journeymen, etc.
 - b. Though not supporting himself by manual labour, yet being of the *same means and social level* as those who do so, (such as shopkeepers who have only petty stocks and employ no one but members of their own family,) policemen, coast-guards, etc.
 - c. Though not supporting himself by manual labour, yet such as it would be unreasonable to expect to pay the fee of middle class students, as some descriptions of clerks, shopmen, etc., and we certify that they or—in case they are not earning their own livelihood—their fathers are not assessed to the income tax.
 4. That they are entitled to be considered as a special case on the following grounds :—
- _____
- _____

We hereby certify that the above particulars are correct.

Chairman or Secretary.†
 { Two members of the
 Committee.†

* After each name must be stated all the successes of the candidate at the May Examinations and the category under which he claims.

† Should the candidate not have been a student in any Science School or Class under a regular constituted Committee, this voucher must be certified by three householders whose occupation and address must be given in full.

SCIENCE FORM, No. 88.

LOCAL COMMITTEES FOR SCIENCE SCHOOLS
AND CLASSES.

1. A Local Committee of not less than five *well-known* responsible persons must be formed in connexion with every Science class, in order to comply with the necessary requirements of the Science and Art Department, and to carry out various arrangements on its behalf necessary for testing the efficiency of the science instruction, on the proof of which alone the aid of the Department is given.

2. The gentlemen proposed to act on this Committee are to fill in the form on the next page, stating their willingness to carry out the necessary arrangements for examinations, &c., and giving the address and occupation of each member.

3. The relation of the Committee to the teacher of a Science school or class will vary much according to the varying circumstances of different localities. In some places where the demand for science instruction is great, and there is an energetic local teacher to take advantage of it, the chief duty of the Local Committee may be to give the teacher the necessary vouchers for obtaining his payments. While in other places, where those who take an interest in and wish to further science instruction may, with that object, subscribe to and establish scientific classes either in connexion with an existing institution or not, and may engage a teacher certificated in science to instruct the classes, the teacher must, to a great extent, be the paid officer of the Committee. With these local arrangements the Science and Art Department does not interfere, but leaves them to the locality to settle. The local circumstances will determine whether, as in the first case, the master receiving the whole of the fees for instruction should provide at his risk the room for instruction, with the necessary firing, lighting, &c., or what, as in the second case, should be the proportion of the fees deducted on this account by the Committee.

4. The Science and Art Department requires that the Local Committee shall—

- a. Be responsible for the safe custody of all apparatus towards the purchase of which the Department has paid 50 per cent.
- b. That they shall provide a room or rooms of sufficient size to carry out the annual examination according to the detailed regulations under that head. This examination is of *all* persons who wish to present themselves, and not only of those taught by the certificated teacher; but those persons who are not taught by the certificated teacher must send in their names before the 1st March, and may be required to pay a registration fee of 2s. 6d. for the whole examination.
- c. That a school register, showing the attendance, number of lessons, payment of fees, &c., on an approved form, be kept properly filled up, and sent to the Science and Art Department when required.
- d. That they shall send in to the Secretary of the Science and Art Department the list of students to be examined, before the end of March, specifying the subjects in which they are to be examined. That they shall be responsible for conducting and superintending the examination: giving out the examination papers which will be

sent for that purpose: seeing them worked fairly and certifying to the same, not less than three of the Committee being always present: and sending the worked papers, under seal, by the day's post to the Secretary of the Science and Art Department.

- e. That they shall certify, firstly, that those students on whose examination the teacher bases his claim to payments on results, are artisans or operatives, or their children, or can claim as such (see Science Form, No. 51); and, secondly, that they have received 25 lessons at least from the teacher in the year or since the last examination, on their passing at which payment was claimed on their account.

5. The Science school or class must be at all times open to the visit and inspection of the officers of the Science and Art Department as a condition to the grant of aid from it; if at any time it is found that the apparatus, &c., towards the purchase of which a grant has been made is not properly taken care of, or that a proper room with firing, lighting, &c., is not provided for the class, the aid of the Department will be withdrawn.

NOTE.—As it is to the Committee that the Department looks to carry out the great proportion of the duties of the school, as many as possible of the members of the Committee should attend on the inspector's visit.

FORM OF APPLICATION to act as a COMMITTEE for a SCIENCE SCHOOL or CLASS.

We the undersigned,

- f. The Committee shall be composed entirely of well-known responsible persons of position who are quite independent of the school or class, and who have no such personal interest in it as can lay them open to the slightest suspicion of partiality; and of course no member should be connected with the Teacher, have any pupils for examination, or be a pupil himself.
- g. It is very desirable that as many persons as possible in recognized positions of public responsibility in the district, such as Magistrates, Municipal Authorities (Mayor, Aldermen, or Town Councillors), Heads of Educational Establishments (Trustees of Grammar Schools, Managers of National Schools), Clergymen, &c., should be on the Committee.
- h. It is absolutely necessary that at least two such responsible persons should agree to act.
- i. The Committee must consist of a Chairman, Secretary, and at least three other Members.
- k. The Chairman must be a Magistrate, Mayor, Boroughreeve, Provost, or Alderman, or other public officer of recognized position, Trustee of Grammar School, or Clergyman of the Established Church in parochial employment.
- l. The Chairman of the Committee will inform My Lords as to the constitution of the Committee being in accordance with these requirements.
- m. The Secretary of the Committee of the Science School or Class, as being the medium of communication, will carry on all correspondence with the Science and Art Department, and is held responsible for making out and sending all returns required, for the receipt and distribution of the examination papers, the transmission of the worked papers, &c., at the proper times according to the regulations; and in consequence of the necessary demands on his time and trouble My Lords have sanctioned, provisionally, the payment to him of the following fees:—1*l.* annually for furnishing the returns, &c. specified on Science Form, No. 170, connected with any Science school or class, and 1*l.* in addition for each day's examination held by the Committee to which he is Secretary. The Secretary must be a member of the Committee; the requirements in par. 1 apply equally to him.
- n. This form is to be filled in and returned to the Department annually before the 15th December, except in the case of new schools or classes, when it should be made as soon as they are formed.]

propose to act as the Local Committee for the Science Class held at

and taught by _____

We undertake for the year _____ at least, and further till another Committee satisfactory to the Science and Art Department has been appointed,

1. To be responsible for the safe custody of all the Apparatus, Diagrams, &c., towards the purchase of which the Department has in any way contributed.
2. That three or more of our number will be ready at the appointed time to be present at, and superintend, the examinations of the Science Class according to the instructions of the Science and Art Department, and give the teacher the necessary vouchers.
3. That a room or rooms shall be provided for the due carrying out of such examination, according to the rules of the Department, providing sufficient space for the examination, not only of all persons taught by the certificated teacher, but of all others who may wish to attend the examination.

(A fee of not more than 2s. 6d. may be charged on each applicant for examination who is not a student in the class, to reimburse the Committee in any extra expenses they may be put to in providing a room).

4. That the School or Class shall be open at any time to the visit and inspection of the Officers of the Science and Art Department.

SIGNATURE.	ADDRESS.	Occupation, specially stating how fulfilling the conditions of "g." and "k." above.
_____ <i>Chairman.</i>		
_____ <i>Secretary.</i>		

I certify that this Committee complies with the requirements of the rules f, g, h, i, and k.

Chairman.

The Secretary,
Science and Art Department.

This form may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 168.

Where the same Committee proposes to act again it will not be necessary to re-sign the above, No. 88, but only to hold a meeting and fill up this form, No. 168, which may be had on application.

SCIENCE FORM, No. 88 a.

**LOCAL COMMITTEES FOR SCIENCE SCHOOLS AND CLASSES
NOT RECEIVING AID FROM BUT EXAMINED BY THE
SCIENCE AND ART DEPARTMENT.**

This Form is a modification of the previous, No. 88., and may be had on application to the Secretary, Science and Art Department, South Kensington.

SCIENCE FORM, No. 120.

SCIENCE CLASSES UNDER CERTIFICATED TEACHERS.

ANNUAL REPORT OF SCIENCE SCHOOL OR CLASS,

To be made on its establishment, and annually (immediately on the re-assembling of the class after the summer vacation) of its continuation.

Name of Town _____

Place, as Mechanics' Institution, &c., in which the Classes are held _____

Name of Street, No., &c. _____

Name of Teacher or Teachers _____

Their private addresses _____

Total No. of individual Students _____

(If a student attends two or more classes he must only be counted as one student.)

CLASSES IN (state subject).	Fees.	No. of Students.	Days on which they meet.	Hours of Meeting.	Period of the Year during which the Classes continue.

NAMES OF SECRETARY AND MEMBERS OF THE COMMITTEE.

(The undertaking on Science Form, No. 88, is for the year at least, and further till another Committee satisfactory to the Science and Art Department has been appointed. This Form, No. 88, must therefore be filled in and sent to the Department annually when the class recommences, except in those cases in which the whole of the Committee, wishing to continue, formally authorize the Chairman and Secretary to report to that effect. It will then only be necessary for new members to sign the form undertaking to perform the various duties.)

SCIENCE FORM, No. 119.

APPLICATION FROM

SCIENCE SCHOOL FOR EXAMINATION IN MAY.

To be sent to the Secretary of the Science and Art Department before the end of March.

Number of students under instruction during the year } Number intending to present themselves for examination } Number intending to present themselves for examination not belonging to the class }	I.	Practical Plane and Solid Geometry.	II.	Mechanical and Machine Drawing.	III.	Building Construction.	IV.	Elementary Mathematics.	V.	Higher Mathematics.	VI.	Theoretical Mechanics.	VII.	Applied Mechanics.	VIII.	Acoustics, Light, and Heat.	IX.	Magnetism and Electricity.	X.	Inorganic Chemistry.	XI.	Organic Chemistry.	XII.	Geology.	XIII.	Mineralogy.	XIV.	Animal Physiology.	XV.	Zoology.	XVI.	Vegetable Physiology and Economic Botany.	XVII.	Systematic Botany.	XVIII.	Mining.	XIX.	Metallurgy.	XX.	General Navigation.	XXI.	Nautical Astronomy.	XXII.	Steam.	XXIII.	Physical Geography.
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Total number of students * under instruction during the year.

Total number of students * intending to present themselves for examination.

Name of place where the examination is to be held. Name and address of the person to whom the examination papers are to be sent.

N.B.—The address must be that to which the *Examination papers* are to be sent.

Specify here the arrangements which have been made in accordance with § XIII. of the Science Directory to conduct the examination of any other classes in the town (if there be any) at the same centre.

* The total number of *individual* students only should be here given, so that if one student attends two or more classes he must only be counted as *one*.

Application from _____ Science Teacher in _____
School or Institution at _____ for payment.

- (1). That Mr. _____ has duly performed the various duties devolving upon him as a Science Teacher in the School, during the _____ ending _____ day of _____ 186 .
- (2). That he has given the following Students at least 25 lessons during the year, or since the last examination at which payment was claimed on their account, in each subject for which payment is claimed.
- (3). That the under-mentioned students are *artizans or operatives* in the receipt of weekly wages, supporting themselves by their own manual labour; or their children not earning their own livelihood.*

Two mem-
bers of
Committee.

Teacher.

[illegible]

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[SPECIMEN.]

Science Form, No. 51.
South Kensington, July 1865.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF
COUNCIL ON EDUCATION, SOUTH KENSINGTON.

Application from *John Smith*, Science Teacher in the *Science School*
or Institution at *Midhurst* for payment.

On behalf of the Committee of Management of this School, We do
hereby certify:—

- (1.) That *Mr. J. Smith* has duly performed the various duties de-
volving upon him as a Science Teacher in the School, during
the year ending 31st day of *May* 1865;
- (2.) That he has given the following Students at least 25 lessons
during the year, or since the last examination at which payment
was claimed on their account, in each subject for which pay-
ment is claimed;
- (3.) That the under-mentioned students are *artizans or operatives* * in
the receipt of weekly wages, supporting themselves by their own
manual labour; or their children not earning their own livelihood.

Wm. Brown, Secretary.

John Jones, { Two mem-
James Robinson, { bers of
Committee.

I hereby certify that the following particulars are correct.

John Smith, Teacher.

NAMES OF PASSED ARTIZAN OR OPERATIVE STUDENTS.*

N.B.—The names of the students must be arranged alphabetically. After each student's
name must be placed his several successes (if he has more than one); and in the last
column the amount claimed on each success after making the proper deduction.

Surname.	Christian Name in full.	Age last Birthday.	Trade, or father's trade. (State which is given).	Position at the late Examination.		Highest Posi- tion in same Subject at any previous Examination.	Payment claimed.
				Subject.	Grade.		
<i>Adams,</i>	<i>James,</i>	22	<i>Carpenter,</i>	<i>X.</i>	<i>1st</i>	—	£ s.
"	"	"	"	<i>XI.</i>	<i>2nd</i>	—	5 0
"	"	"	"	<i>XIV.</i>	<i>Pass</i>	—	1 0
<i>Barber,</i>	<i>John Wm.</i>	14	<i>Butcher (f)</i>	<i>X.</i>	<i>1st</i>	2nd	0 10
	<i>Henry.</i>						0 10
<i>Smith,</i>	<i>William,</i>	12	<i>Baker (f)</i>	<i>XI.</i>	<i>4th</i>	—	2 0
				<i>I.</i>	<i>1st</i>	—	5 0

* Should the Teacher have instructed any Students who may fairly be considered to
belong to the industrial classes, but whose wages are paid at longer intervals than a
week, or who do not support themselves by their own manual labour the claims on
their account must be made by the Committee of the school on the form on page 3,
when they will be considered on their merits.

SCIENCE FORM, No. 108.

Application from _____ Secretary of the Local
Committee for the Science School or Class at _____
for payment of allowance for duties connected with the School, and for
superintending the examination.

Sir,

*Being entitled to payment according to the regulations of the
Science "Directory,"* for duties connected with the Science Class at _____
and for superintending the arrangements
for carrying out the examinations on _____ the following days
in May 186 , I request that the sum of £ _____ may
be paid to me, being the authorized fee.*

Dates of Examination.

Dates of Examination.

Dates of Examination.

I am, Sir,

Your obedient Servant,

The Secretary,

Science and Art Department.

**CONDITIONS UNDER WHICH APPARATUS, INSTRUMENTS, BOOKS,
&c. MAY BE OBTAINED BY SCIENCE SCHOOLS OR CLASSES
(TAUGHT BY A TEACHER CERTIFICATED IN SCIENCE),† IN
PUBLIC SCHOOLS, MECHANICS' INSTITUTIONS, &c.**

1. The Lords of the Committee of Council on Education, having had under their consideration several applications from the managers and masters of Mechanics' and other Institutions, for grants to be made to them of Apparatus and Illustrations, recommended by the Science and Art Department for teaching science, think it necessary to adopt some general principle which shall regulate the decisions of the Committee in reference to such applications.

* £1 annually for furnishing the returns, &c. specified on Science Form No. 170, connected with any Science school or class, and £1 in addition for each day's examination held by the Committee to which he acts as Secretary.

† Apparatus not exceeding 10*l.* in value may be obtained by poor Schools and Mechanics' Institutes, not taught by a certificated teacher, under the same conditions, that is, the Department will aid them to the extent of 5*l.*

Their Lordships have already fully recognized the great importance of practical science to all classes of the community, in all relations of life. They are, therefore, desirous that the Science and Art Department should assist, as far as possible, in promoting the distribution of diagrams and apparatus as the means of accomplishing this object; but as the indiscriminate gift of these aids for instruction to all applicants might lead to abuse, it is necessary to require some guarantee that they will be duly appreciated, which the mere request to have them does not imply.

The principle which governs the whole proceedings of the Department in all its branches is to afford partial aid, and to encourage, but not supersede public exertions in promoting education in science. They have, therefore, resolved that the Department shall have the power to assist schools and classes taught by a certificated teacher in Mechanics' and other institutions in purchasing diagrams and apparatus for teaching science at a reduction of 50 per cent. on the net cost.

Lists of the scientific diagrams and apparatus prepared by the Department, according to conditions of the following Minute, may be obtained of the Secretary of the Science and Art Department, South Kensington, London, W. It should be distinctly understood that the aid of the Department in purchasing these articles at a reduced price, if above 10*l.* in value, can be granted only to public schools and institutions when taught by a *certificated teacher*.

Minute of the 23rd March 1860.

"The Lords of the Committee of Council on Education desire to afford the greatest facilities to teachers of science and navigation schools in obtaining the best instruments, apparatus, &c., for giving instruction in science and navigation, towards the purchase of which the Science and Art Department is authorized to pay 50 per cent. of cost; and they consider that the fullest opportunities should be given to manufacturers in all parts of the Kingdom for supplying such apparatus, &c. At the same time it is necessary that the Science and Art Department should have some guarantee that the apparatus and instruments are of good quality, and moderate in price. My Lords have therefore laid down the following rules and conditions:—

"1. Samples of all articles on the manufacturer's list are to be sent to the Educational Collection, South Kensington Museum, for exhibition, where they will be arranged separately, according to the science for which they are intended, so as to afford teachers and others facility in inspecting them and making a choice.

"2. The manufacturer is to supply priced catalogues of such articles printed in demy 8vo., in order that the various catalogues may be bound up together and supplied when asked for.

"3. The manufacturer is to guarantee that the articles exhibited are fair samples of those specified in the priced catalogue, and he must engage to take back any article supplied to schools which may be inferior to the standard."

Manufacturers willing to comply with these conditions are to make a statement to that effect, and to send lists of apparatus, instruments, books, &c. in the following sciences:—1. Practical plane and descriptive geometry, mechanical and machine drawing, and building construction; 2. Physics (mechanical and experimental); 3. Chemistry; 4. Geology and mineralogy; 5. Natural history (zoology and botany, vegetable and animal physiology); 6. Navigation and nautical astronomy, and physical

geography. If these lists and prices are such as can be approved of, the manufacturer will be informed, and as soon as possible on his fulfilling the conditions, his list will be inserted in the catalogue. The catalogue will undergo a revision at least once a year, when manufacturers may send any improved forms of apparatus, &c.

The selection of the manufacturer will lie wholly with the Committee of the school. On their demand being sanctioned, the manufacturer will receive instructions to supply the articles upon his receiving the 50 per cent. due from the school.

On obtaining a receipt from the Committee of the school (which is included in the form of the requisition) that the articles have been received, the remaining 50 per cent. will be paid quarterly to the manufacturer by the Department.

2. Payments, including charge for packing, must be made in *advance* to the agents on receipt of the invoice. The goods to be sent at the risk of the purchaser.

All communications to be addressed to the Secretary of the Science and Art Department, South Kensington, London, W.

By Order of the
Committee of Council on Education.

N.B.—Apparatus grants will in future be rigorously confined to articles of a permanent and non-destructible nature; hence no aid will be afforded in the purchase of breakable articles, such as glass retorts, test tubes, &c., or, indeed, generally in the purchase of articles to be used by the student as distinguished from those of a permanent and illustrative character which are required by the teacher in giving instruction in science.

Grants are only made in the purchase of one object of the same kind. Duplicates of apparatus, &c. are not allowed at the reduced rate.

SCIENCE FORM, No. 49.

Form of Requisition which may be had on application to the Secretary, Science and Art Department.

The following Requisition for Aid in purchasing apparatus, &c., after being filled up as required, is to be transmitted to "The Secretary of the Science and Art Department, South Kensington, London. W."

N.B.—It is to be understood that the Department has a lien on the apparatus, &c., furnished to public institutions to the amount of the public aid given in supplying them; they cannot therefore be sold.

1. REQUISITION for AID in purchasing apparatus, &c.

For the use of _____ School or Institution (*)
In the City or Town of (*) _____
In the County of _____

No. 1 application to be filled in by Requisitionist, with full particulars.

	Male	Female	
Having _____			(*) Pupils (Artizans or Operatives) of the Science Class.
(*) Erase the words that do not apply.			
and _____			(*) Scholars or Members of Poor School or Mechanics Institute.
			Total.

I request the aid of the Department in obtaining from M _____ the apparatus, &c., named in the opposite page, and I undertake that the same shall be kept and used in the above-mentioned (*) school or institution for which they have been demanded.

The address to which the parcel is to be sent is as follows:—

To be forwarded to _____
per _____ at _____

Dated this _____ day of _____ 186 .
Signature of Requisitionist.

2. Requisition sent to M _____ day of _____ 186 . Agent, _____
this and authority given for the supply of Articles to the extent of _____
of _____
Net Sum

No. 2 to be filled in by the Department.

of which £ _____ will be paid by the Department, and £ _____, together with the cost of packing, by the school or institution, previous to the goods being applied.

Assistant Secretary.

3. Invoice of articles sent to Requisitionist as under, this _____ day of _____ 186 .
of _____ Articles (Retail Price) £ _____
Deduct as above,—
Aid by Department
Add, for packing
Total to be paid by Requisitionist

No. 3 to be filled in by agent on transmission of the invoice.

4. Amount £ _____ received from schools this _____ day of _____ 186 .
Agent.

No. 4 and 5 to be filled in by agent.

5. Examples forwarded as directed above, together with Requisition, this _____ day of _____ 186 .

6. Examples as per invoice received, and *Requisition returned to Agent, this _____ day of _____ 186 .
Requisitionist.

No. 6 to be filled in by Requisitionist.

* It is requested this paper may be returned to the Agent in an entire state after the examples have been received.

SCIENCE FORM, No. 91.

RULES FOR THE CONDUCT OF SCIENCE EXAMINATIONS.

1. The following rules must be hung up in the examination room for the information of the candidates one week before the examination. They should all be carefully read by the members of the Committee. Those marked with an asterisk must be read aloud before the Committee and the candidates on each night immediately before the examination begins.

2. A room or rooms of such a size that, when seated, the candidates shall be at least five feet apart, from centre to centre, must be provided for the examination.

3.* All Diagrams, &c. must be removed from the walls of the examination room.

4. Ink and blotting paper must be provided. All arrangements for the accommodation of candidates must be completed by 6.30 p.m.

5. If one room is used three of the Committee must be present during the whole of the examination, if more than one room then two of the Committee per room,† who must carefully watch the whole examination and see that candidates use no unfair means either by assisting one another or using books or notes. The members of the Committee can, if they wish it, relieve one another, so long as the correct number are always present. No persons not on the Committee are permitted to be present.

6. The examination papers will be forwarded, under cover, to the Secretary of the Committee so as to be received by him on the morning of the day before that fixed for the examination.

7.* The candidates must be seated at their places at 6.50 p.m. After this time no candidate shall be admitted except under very exceptional circumstances, and that only by express permission of the Committee, and if no person who has seen the examination paper has left the room. No candidate may on any account be admitted after 7.30 p.m.

8.* The examination papers must be opened in the examination room in the presence of the Committee, at 6.55 p.m. No examination paper may be taken from the room till after 8 p.m.

9.* When the candidates are seated and the papers given out, the Committee will see that the candidates *commence* by filling in their names, &c., where directed. All the worked papers must be collected at 10 p.m., initialed, put under cover, and sealed in the presence of the members of the Committee; and forwarded by the *first post* to the Secretary of the Science and Art Department.

10.* Candidates must on no account bring anything with them into the examination room,‡ except pens and pencils. No scribbling paper, slates, or anything of that nature must be allowed.§ Arrangements must be made by which all books, note-books, &c., can be given up and left at the door.

11.* Candidates must not on any pretence whatever speak to one another after the papers have been given out. If a candidate should require to ask a question, he will hold up his hand, when a member of the Committee will attend to him, but no question on the meaning of any portion of the examination paper must be asked or answered.

12. It may be of service to the Committee that the teacher of the

† When there are not more than three candidates it will not be necessary for more than two members of the Committee to be present at the examination.

‡ Except such as by the Time Table (Science Form, No. 90) are required.

§ It is absolutely necessary that nothing that can be passed from one candidate to another should be allowed. Rough work and calculations must be done on the supplied form, the back of each leaf of the form, *i.e.*, pages 2, 4, 6, and 8, may be reserved for this purpose, the pen being drawn through to show that they are not for the examiner. *But nothing must be torn off the form.*

class should attend before the examination begins to assist in getting the candidates into their places, &c.; but from the peculiar character of the examination it is so very necessary that not the slightest opportunity for misconstruction should exist that it is evident that he should not be in the room after the examination papers are opened. Information of his having remained in the room after this will at once lead to the examination being declared null.†

13.* The examination papers being given out no candidate must be allowed to return after having once left the room.‡ On a candidate leaving the room his papers must be taken up.

14.* At 10 p.m., precisely§, all the candidates must cease working, and members of the Committee will collect their worked papers from them at their places. It will therefore be advisable to warn them ten minutes before the time. The papers will be initialed, by the Committee as directed, as they are received from each candidate, as a guarantee that each has been worked by him whose name, &c. it bears. Should a candidate have completed his work before 10 p.m. he may, by permission of the Committee, go away at once, after his worked paper has been taken by a member of the Committee.

15.* Should a candidate break any of the foregoing rules, ask from or give information to another, or use unfair means of any description, he must be at once expelled the examination room, and his paper cancelled, and the Committee will state on it the cause of his expulsion.

16. On these examinations depend large grants of public money. On their being fairly, honestly, and impartially carried out depends the continuance of the system. The Committees are intrusted with this duty. They will see, then, how necessary it is to be extremely careful in conducting them, and to insist on the foregoing rules being complied with *to the letter*. They are therefore required to sign and forward this form with each set of worked papers.

We, the undersigned, members of the Committee of the Science School or Class held at _____

hereby certify that we were present during the examination in _____ held in the _____

on the evening of the _____ where the accompanying papers were worked in our presence, and that the foregoing rules have been strictly complied with.

Dated this _____ day of _____ 186 .

Signatures.	Time Present.
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

† Should the teacher of the class wish to compete at this examination for the Royal Exhibitions, he must apply specially to the Committee for permission, so that they may arrange to have a table for him close to their own seats, and not with the other candidates.

‡ It will, therefore, be desirable to make some arrangement for the candidates to retire within the room.

§ Except in the Drawing Examinations, subjects 1, 2, and 3, then the hour is 11 p.m.

SYLLABUS OF THE SUBJECTS IN WHICH EXAMINATIONS IN SCIENCE ARE HELD BY THE DEPARTMENT OF SCIENCE AND ART.

THE following Syllabus has been prepared in order to afford candidates some guide to their reading; but it must be understood that the questions in the examination need not necessarily be on the specific points enumerated.

The examination is by paper, but oral examination may be resorted to. The examination in each subject is distinct. Mention is made of textbooks solely to afford a candidate some assistance in selection and a general idea of the scope of the examination, *and not at all to confine his reading to those works or to assert that they are the best on the subjects they treat of.*

A Course of Lectures as detailed below, on "Preparation for obtaining "Science Certificates and the Method of teaching a Science Class," has been delivered by direction of the Lords of the Committee of Council on Education. The lectures may be purchased, price 2d. each, at the book stall, South Kensington Museum, or on application by letter, enclosing postage stamps, to the Secretary, Department of Science and Art, South Kensington, London, W.

Geometrical Drawing, &c.	Prof. T. Bradley.
Mechanical Physics	- Rev. B. M. Cowie, M.A.
Chemistry	- - Prof. Hofmann, F.R.S.
Geology	- - Prof. Ramsay, F.R.S.
Mineralogy, &c.	- Prof. W. W. Smyth, M.A., F.R.S.
Zoology	- - Prof. Huxley, F.R.S.
Botany	- - Edwin Lankester, M.D., F.R.S.
Navigation and Nautical Astronomy.	J. Riddle, F.R.A.S.
Physical Geography	- Dr. G. Kinkel, F.R.G.S.

A Second Course has been delivered, of which the following have been published:—

Lecture I. - Vegetable Physiology and Economic Botany.	Edwin Lankester, M.D., 3rd February. F.R.S.
Lecture II. Mechanical Physics	Rev. B. M. Cowie, B.D. 10th February.
Lecture IV. Mining	- W. W. Smyth, M.A., 24th February. F.R.S.

SYLLABUS.

Subject I.—Practical Plane, and Solid Geometry.

Practical Geometry, plane and solid; required by architects, engineers, mechanists, shipbuilders, and others employed in arts of construction.

The candidate is assumed to have acquired readiness in the use of the usual drawing instruments and materials, to be skilful in drawing lines and circles in Indian ink, plain or dotted, of different degrees of fineness; drawing parallel equi-distant lines, at least six inches long, and from five to twenty or thirty in an inch; drawing from ten to thirty lines, passing through one point and forming equal angles; dividing by trial lines and arcs into any number of equal parts. He should also be able to mend his drawing pens and other instruments, and to verify his rulers, &c. Two or three questions in the first or easy paper are intended to test his skill in these respects.

Constructions in Plane Geometry.

1. To draw lines through given points, in every position, either parallel, perpendicular to, or to form any proposed oblique angle, with given lines.

The use and construction of the *protractor*, and of the "scale of chords" for these purposes, should be understood, and the deduction of certain angles from the direct division of the circle.

2. To draw circles or arcs, through given points, to touch given lines or circles, and, conversely, lines to touch circles.

Required in drawing framework for machinery, architectural designs, ornamentation, &c.

3. The principles of drawing symmetrical forms by means of co-ordinates to the axis of symmetry.

This is the basis of all drawing, of objects of construction, which are always symmetrical, not only in architecture, civil and naval, but in machinery and engineering works of all kinds.

4. Constructions of figures *similar* to given rectilinear or mixtilinear figures.

Here the construction and use of "scales" plain and comparative, should be thoroughly understood and explained, and the principles of the *diagonal* division of scales. Also the mode of reducing or enlarging drawings by means of similar rectangles, termed *squaring* a drawing. The use of the sector and of proportional compasses in facilitating copying should be known.

5. To construct rectilinear figures similar to given ones, but with a proposed area.
6. To determine by construction numerical quantities such as \sqrt{m} ; $\sqrt{\frac{1}{m}}$; $\sqrt{a^2 \pm b^2}$, &c.

7. To construct a triangle, any three parts being given.

§ 1. Used in levelling, surveying, and the determination of heights and distances. Great accuracy, neatness, and distinctness of construction, will be insisted on: Geometrical drawing is valueless unless it possesses these requisites.

§ 2. A few illustrations of constructions on the ground, by means of a "chain," pins and cords, necessary in surveying, and "setting out" buildings and earthworks, may be added to the course, as well as the solution of a few elementary problems by means of the compasses alone.

8. The delineation of a few of the curve lines required in the arts, such as the ellipse, cycloidal curves, the involute and sinusoid, with the graphical method of determining their tangents and normals.

Required in designing elliptic arches, oblique bridges, teeth of wheels, cam-work, screws, &c.

9. Practice in tinting and shading with Indian ink, so as to express curved surfaces and shadows.

Both papers contain questions from sections, 1, 2, 4, 5, but those of the second or more difficult paper are chiefly from sections 4, 5, 7, and 8, and only rarely from 3, 6, 7, and 9.

For the preceding part of the course, a fair knowledge of the first four books of Euclid is necessary, some acquaintance with elementary trigonometry is also desirable.

Constructions in Solid Geometry.

(Descriptive Geometry.)

A general knowledge of the principles of *projection* on two (co-ordinate) planes, as necessary to define or represent any geometrical solid, is necessary to gain any certificate in this subject. These projections are termed *plans, elevations, profiles, or sections.*

The questions in the first or easy paper demand only this elementary knowledge, the candidate being required to represent by their projections simple solids, such as prisms and pyramids, or others formed by their combinations.

But to obtain a second or first class the candidate must be acquainted with the methods of solving problems on the combinations of points, lines, and especially planes, independent of any solid form or *volume* of which they are the elements.

He should also know something of the geometry of *curved surfaces*, as the sphere, cylinder, and cone, and of the mode of representing all surfaces graphically by the projections of their generators. For the following subjects he must know how to determine planes to touch or tangential to such surfaces; but candidates are not expected to be more than generally acquainted with these subjects. Occasionally, however, easy questions in the following are inserted in the second paper.

Applications to the intersections of surfaces, and of the development of such as admit of it.

This may be considered the most important part of descriptive geometry to the artisan, as it is required in all arts of construction. The mason, carpenter, and shipwright, workers in tin-plate, boiler makers, &c., must all possess some knowledge of it.

The solution by construction of the spherical triangle from any three given parts, is mentioned.

As important to masters, mates, and others engaged in any kind of astronomical calculations.

Isometric Projection

Is usefully employed in the representation of works, chiefly of a rectangular form, such as timber framing, canal-locks, and many parts of machinery; its use is increasing: it is readily understood, and can be practised by anyone who has gone through the previous articles of this section.

Perspective or Radial Projection

May be taken up, but will not be insisted on as it is rarely used except by architects to represent buildings (not yet executed), as they would appear to the eye at any spot from which they could be viewed, and the power of applying it for this purpose is possessed by many who know little of the really easier subject of descriptive geometry; but as its application by the architect must be subordinated to artistic taste, this consideration excludes it, in some measure, from a purely geometrical course.

No one, however, can be considered a scientific draughtsman unless he can apply perspective projection to the projection of shadows, the projections of the sphere, the constructions of maps and dials, and some other uses.

For the second division of this course, in addition to what was before indicated, a competent knowledge of the theorems relating to the line and plane (Euclid, Book XI.) is essential.

The following are some of the best works on the subject of Practical Geometry, but the list is not given as a complete one:—

For Theoretical Geometry.—1. *Geometry, Plane, Solid, and Spherical, &c.* (Library of Useful Knowledge), published originally by Baldwin and Cradock, undoubtedly the best work on the subject.—2. *Geometry, &c.*, by Mr. Bell, in Chambers's Educational Course, both comprehensive and excellent.—3. There are excellent elementary works based on Euclid in Gleig's School Series, and in that published by Messrs. Galbraith and Haughton in Ireland, also in Weale's Series, &c. &c.

For Practical Geometry.—Bradley's *Geometrical Drawing*, published for the Committee of Council on Education by Messrs Chapman and Hall. — Bradley's *Practical Geometry, Perspective and Projection* (Library of Useful Knowledge). — Hall's *Elements of Descriptive Geometry for Students in Engineering*. — Heather's *Descriptive Geometry for Students in Engineering* in Weale's Series. — Also works by Winter, Burchett, and Binns.

French works on this subject are numerous and excellent, by Lacroix, Lefebvre de Fourcy, Leroy, Le Vallée, Adhemar, Bardin, &c. &c.

Subject II.—Machine Construction and Drawing.

The application of the foregoing Subject I. to the drawing of machinery, in which great accuracy and neatness of drawing will be insisted on.

The candidate will be required to take measurements with calipers, &c., and to make drawings, elevations, and sections of a simple machine, or of parts of one, set before him. Also to draw a portion of a machine from written dimensions and description. He will be required to have sufficient knowledge of the principles of machinery, gearing, &c., to be able to make working drawings of a machine or portions of a machine from a rough sketch, applying the power to the greatest advantage, and obtaining such power or changes of motion as are required. In fine, such knowledge and readiness as would be required of a good draughtsman in an engineer's office.

Subject III.—Building Construction, or Naval Architecture and Drawing.

(See previous Subject.)

The candidate will be required to possess sufficient knowledge of construction—(1) to apply the various materials used in building to their greatest advantage; (2) to be able to make detail and working drawings showing a knowledge of the methods of construction and the framing of ordinary roofs, bridges, &c., whether of wood, iron, or masonry; (3) to frame estimates and take out quantities.

Neatness, accuracy, and facility in drawing will be insisted on, and the general requirements in this Subject will be such as would be possessed by a good draughtsman in an architect or builder's office, with a slight scientific knowledge for the proper application of the materials he is required to work with.

N.B.—Naval Architecture may be taken instead of Building Construction; the same description of attainments will be required.

Subject IV.—Elementary Mathematics.

1. *Arithmetic generally.*
2. *Geometry.*—The properties of lines, triangles, rectilinear figures, the circle; properties of similar figures; proportion of figures; inscribed and circumscribed polygons. The questions will have reference to Euclid's elements; but a sound knowledge of Geometry obtained from any source will be accepted.
3. *Algebra.*—Definitions. Addition. Subtraction. Multiplication. Division. Greatest common measure. Least common multiple. Theory of indices (integral). Involution. Evolution. Simple equations, and problems producing them. Fractions. Quadratic equations, and problems producing them. Ratio. Proportion. Variation. Arithmetical, geometrical, and harmonical Progressions, Permutations, and Combinations. Binomial theorem for a positive integral index.
4. *Plane Trigonometry.*—Definitions. Conversion of degrees and their subdivisions into grades, and their subdivisions, and *vice versa*. Angular and circular measures of degrees and their relation. The goniometric functions of angles and the conversion of one into another. The arithmetical values of the goniometric functions of 90° , 45° , 60° , 30° , 180° , 120° , 150° , &c. The meaning of contrariety of signs in trigonometry. Tracing of the goniometric functions in magnitude and algebraic sign through the four quadrants and when an angle is indefinitely increased.

Formulae for multiplication and division of angles, viz., sine, cosine, tangent, &c., of $(A \pm B)$, $2A$, $3A$, $\frac{A}{2}$, and $\frac{A}{3}$. Also of A and B in terms of $\frac{A+B}{2}$ and $\frac{A-B}{2}$.

Logarithms.—Definition. Multiplication, Division, Involution and Evolution by logs. The use of logarithmic tables. Tables of proportional parts for numbers and angles. Modulus. Construction of logarithmic tables, and of tables of logarithmic sines, cosines, &c.

Triangles.—Formulæ for cosine of an angle of a triangle in terms of its sides. The relation between sines of angles and the opposite sides; sine, cosine, tangent, &c., of half an angle of a triangle in terms of sides, and of the sine of an angle. Area of a triangle. Solution of triangles. Diameters of circles inscribed in and circumscribed about a given triangle. Areas of regular polygons inscribed in and circumscribed about a given circle. Area of a circle. Description and use of vernier and theodolite and sextant (generally). Heights and distances of inaccessible objects.

For students to obtain a 5th class, a competent knowledge of the following alone will be required:—

- (1.) Geometry. The first book of Euclid.
- (2.) Algebra, to simple equations and problems (inclusive).
- (3.) Plane trigonometry. The more elementary portions, including use of logarithms.

To obtain a 4th class:—

- (1.) Geometry. The first three books of Euclid.
- (2.) Algebra, to quadratic equations.
- (3.) Plane trigonometry as far as solution of triangles, inclusive.

And for third, second, and first class Queen's prizes the remaining portion of the above subjects.

Subject V.—Higher Mathematics.

1. *Algebra.*—Surds. Theory of indices (fractional and negative). Binomial theorem generally. Multinomial theorem. Exponential theorem. Indeterminate equations and problems. Indeterminate coefficients. Reversion of series. Properties of numbers.

2. *Plane Trigonometry.*—De Moivre's theorem and the expansion of sine, cosine, and tangent in terms of the angle.

Spherical Trigonometry.—Definitions and fundamental propositions. Polar or supplemental triangle and its properties. Area of a spherical triangle. Spherical excess.

Fundamental formulæ expressing the relations of the sides and angles of a spherical triangle.

Napier's analogies.

Solution of right-angled spherical triangles and of oblique angled triangles.

Mensuration.—Trapeziums. Regular plane rectilinear figures. Irregular plane curvilinear figures (Simpson's or Stirling's Rules). Volumes and surfaces of Parallelopipeds, Pyramids, Cylinders, Cones, and Spheres.

Differential and Integral Calculus.—Definitions. Differential of elementary functions, including circular and logarithmic functions. Vanishing fractions. Maxima and minima of one independent variable. Tangents and normals of curves. Differential coefficients of Areas, Arcs, Volumes and surfaces of solids of revolution.

Integration of elementary functions. Integration by parts. Rational fractions. Integration between limits. Areas and lengths of simple curves. Volumes and surfaces of solids of revolution.

Subject VI.—Mechanics as a Science, or Theoretical Mechanics.

Statics. Composition and resolution of forces. Forces acting on a point—on a rigid body. Parallel forces. Centre of gravity. Theory of moments or couples. Principle of virtual velocities. The mechanical powers. Friction. Equilibrium of roofs and arches.

Dynamics. Laws of motion. Uniformly accelerated motion. Motion by gravity. Variable forces. Projectiles. Centrifugal force. Motion on inclined planes—on curves. Pendulums. Motion of rigid bodies, free or constrained. Moment of Inertia. Centre of oscillation—of percussion. Motion of flexible bodies, such as a musical string.

Hydrostatics, Hydrodynamics, and Pneumatics. Mechanical properties of liquids. Law of pressure. Centre of pressure. Laws of floating bodies. Capillary attraction. Laws of fluid motion, through open channels, closed pipes, or orifices.

Mechanical properties of elastic fluids. Theory of barometers. Connexion between pressure, temperature, and volume. Specific heat. Weight of atmosphere. Use of barometer in calculating heights.

In this subject the candidate will have to show a mathematical knowledge of the laws of Mechanics, and must be able to prove from first principles the principal theorems.

The books recommended for study are—Whewell's *Elements of Mechanics*, or Snowball's; Moseley's *Engineering Architecture*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke; Goodwin's *Elementary Course*.

Subject VII.—Mechanics as an Art, or Applied Mechanics.

General principles of mechanism. *Elementary combinations.* When the connexion is by rolling contact, sliding contact, wrapping connectors or linkwork, with constant or varying velocity ratio, and constant or varying directional relation.

Machines of ordinary occurrence must be thoroughly understood and particular parts to be described and drawn: such as cranes; lathes; drills; planing, punching, boring, shaping, and slotting machines. Spinning and weaving machinery. Mode of calculating power of machinery. Dynamometers, indicators, &c.

Materials. The general properties of materials. Elasticity. Weight. Specific weight. Mechanical work. Work done by pressure, by impact, by expansion of elastic gases and steam, by animal muscular effort.

Resistance to expansion, to compression, to rupture. Friction of solids. Its importance in construction. Resistance of fluids to bodies moving within them. Adaptation of form and material for maximum resistance. Beams of greatest strength. Construction of roofs, arches, stone and timber bridges, suspension bridges, and tubular girders.

Hydrostatics, Hydrodynamics, and Pneumatics. Pressure on flood-gates; locks; water-wheels; turbines; water-pressure engines; breakwaters. Hydrometers. The syphon. Hydraulic ram. Pumps. Diving bell. Condenser. Windmills. Steam-engines, stationary, marine, locomotive. The steam hammer. Water supply to towns. Theory of tides, in the open sea, and in rivers.

In this subject the candidate will be expected to show how the principles are applied in actual practice; he will be expected to show by clear well-drawn sketches, his acquaintance with parts of machines.

The candidate will have tools and models put before him, with some of which he must show he is familiar, and that he can explain their use and construction.

Books recommended:—Willis's *Mechanism*; Baker's *Elements of Mechanism*; the books in Weale's Series which treat on the subjects specified. Twisden's *Practical Mechanics*; Goodeve's *Elements of Mechanism*.

Subject VIII.—Acoustics, Light, and Heat.

Acoustics.

The candidate ought to know the manner in which sound originates, and is propagated; its velocity in different media, and how its velocity through air is affected by density and temperature.

He ought to know the origin of musical sounds; of pitch; of harmony and discord; to commit to memory the rates of vibration of the several notes of the gamut; to be able to make sonorous vibrations visible by means of glass plates and membranes; to calculate the length of sonorous waves, and to determine practically the number of vibrations due to any particular note. He ought therefore to understand the construction and use of the Syren.

He ought to be able to describe and illustrate the condition of a vibrating string, or column of air at its nodal points and ventral segments and to explain echos and resonance.

Light.

The candidate ought to know how its velocity was first determined from observations upon Jupiter's satellites.

He ought to be able to devise a simple means of exhibiting both the reflection and refraction of light; to be able to state the laws of both; to explain what is meant by total reflection; and to apply it to the explanation of the Mirage of the Desert, the Phantom Ship, and other similar phenomena.

He ought to be able to explain why the image in a plane mirror must appear as far behind the mirror as the object is in front of it; why a stick appears bent when dipped obliquely into water; and why the bottom of a river or lake, or of a basin which holds water, appears to be nearer to the surface than it really is.

He ought to be able to determine the positions of the foci of spherical mirrors, both concave and convex; to describe the characters of their images, whether erect or inverted; magnified or reduced; and to do the same for convergent and divergent lenses.

He ought to know the construction of the human eye; the conditions of distinct vision, the use of spectacles; and to be able to describe a simple form of the reflecting and refracting telescope and of the microscope.

He ought to know the constitution of light; to be able to describe the spectrum produced by refraction with a prism; to explain the origin of colours, and to give a clear explanation of the rainbow.

Heat.

The candidate ought to be able to describe the construction and graduation of an ordinary mercurial thermometer; to understand the scales of Fahrenheit, Celsius, and Reaumur.

He ought to have clear ideas of conduction and radiation; to be able to devise some simple means whereby the conductive and radiative powers of different bodies may be determined; to explain fully the formation of dew, and to state the conditions favourable to its production.

He ought to know the effect of heat upon the volumes of bodies; to know what is meant by the coefficient of expansion, and how it may be determined; to give illustrations of the enormous power of heat in

producing expansion; to state exceptional cases; to know the manner in which heat is propagated through liquids and gases, as distinguished from ordinary conduction; and to be able to combine two metals possessing different coefficients of expansion, so as to form a compensating pendulum.

He ought to know the meaning of latent heat and of specific heat, and to illustrate both by reference to ice, water, and steam; he ought to be able to show the influence of the high specific heat of water upon an island climate.

He ought to know the strict physical meaning of ebullition; and the influence of pressure upon the boiling points of liquids; he ought to have a general knowledge of the origin of winds and clouds, and to be able to explain the fact that the rain-fall upon the south-west side of a mountain chain in England and Ireland is much more copious than on the north-east side.

Text Books:—See next subject.

Subject IX.—Magnetism and Electricity.

Magnetism.

The candidate ought to know the action of one loadstone upon another which is freely suspended, or set afloat upon a liquid; he must have a perfectly clear notion of magnetic polarity, and of the action of magnetic poles upon each other.

He must know the difference between the action of magnetised and unmagnetised steel upon a magnetic needle; also the difference between soft iron and hard steel, with regard to their acceptance and retention of the magnetic condition; (coercive force).

He must be able clearly to state the condition of a mass of soft iron when under the influence of a magnet, and in virtue of which condition the iron is attracted; (magnetic induction).

He must be able to describe the action of the earth upon a magnetic needle; must know the meaning of declination, inclination or dip, and of secular and diurnal variation; the action of the earth upon a bar of soft iron according as it is held in the direction of the dip or at right angles to this direction; finally, the effect of percussion in rendering the condition assumed by the bar of soft iron a permanent one.

He ought to be able to compare accurately the strength of one magnet with that of another, and to state how the relative intensity of the earth's magnetism at two points of its surface may be ascertained.

Frictional Electricity.

The candidate ought to know various simple ways of exciting electricity to be clearly informed as to the duplex character of the force; to know the condition of the rubber as well as that of the body rubbed; and to be conversant with various forms of electroscopes and electrometers.

He ought to know the foundation of the terms vitreous and resinous, positive and negative; to be able to illustrate the action of two electrified bodies upon each other; and to tell at once whether a body is positively or negatively charged.

He ought to have a clear knowledge of electric conduction, insulation, and induction; and be able to explain the state of a neutral conductor when acted upon by an electrified body; he ought to be able to prove, experimentally, that though we cannot by breaking a magnet obtain two halves each with a single pole, we can by breaking an electrified body obtain two halves each charged with a single electricity.

He ought to be able to explain the influence of points and flames when attached to an electrified conductor; and to describe the action of lightning conductors.

He ought to be able to describe the electric machine, and the electrophorus; and to explain the action of the condenser and of the Leyden jar.

He ought to be able to state the principal effects of the electric discharge; to state the atmospheric conditions necessary to the production of a thunderstorm; and to give a clear account of the so-called return stroke.

Voltaic Electricity.

The candidate ought to be able to state precisely how voltaic electricity may be generated; to describe Volta's pile, and his crown of cups; and also the batteries of Daniell, Grove, and Bunsen.

He must have a clear conception of what is meant by the direction of an electric current; and be able to illustrate in the fullest manner the action of a current upon a freely suspended magnetic needle. Given the direction of the current, he must be able to state how the needle moves; given the movement of the needle, he must be able to infer from it the direction of the current.

He must be able to describe fully the action of a current upon soft iron; and to infer from the direction of the current the nature and position of the magnetic poles, which it excites.

He must be well acquainted with the chemical reactions which take place both in the batteries, mentioned above, and also in other liquids through which the current may be sent.

He must be able to measure the strength of an electric current, and he is strongly recommended to master thoroughly the law of Ohm, regarding the mutual relations of electromotive force, resistance, and strength of current.

He ought to be acquainted with the so-called polarisation of metallic plates between which a current passes through a liquid, and to show how this is avoided in Grove's battery.

He ought to be able to give a clear description of some one form of the electric telegraph.

He ought to be acquainted with the physiological effects, and with those of light and heat produced by the voltaic current; and to show the dependence of the heat on the strength of the current, and on the resistance which it encounters.

It would also be well to master as much of the phenomena of induced currents as would enable the candidate to explain the action of the galvanizing apparatus used by medical men.

NOTE.—The candidate will perceive that this list is long because the objects to which he is to devote his attention are separately specified. Definition is thus given to his studies and their precise scope marked out for him. He is recommended to repeat with his own hands, as far as it is in his power to do so, the experiments which he finds described in good handbooks of Natural Philosophy; this will give a certainty to his knowledge and an interest to his pursuits which mere reading can never confer. The first requisite demanded of him on his examination will be that, however small his knowledge, it shall be well digested and sound.

Text-Books:—Lardner's *Handbook of Natural Philosophy*; *Natural Philosophy*, by Dr. Golding Bird and Mr. Brooke.

Subject X.—Inorganic Chemistry.

The general principles of chemical philosophy. Laws of combination. Volume weights. Combining weights. Atoms and molecules. Chemical symbols and their use in the explanation of chemical changes. Quantivalence.

The non-metallic elements:

Hydrogen. Water. Chemical composition and properties. Adaptation for domestic purposes. Hardness, permanent and temporary.

Oxygen. Combustion.

Sulphur. Sulphuretted hydrogen. Sulphurous acid, sulphuric acid, hyposulphurous acid, hyposulphuric acid. Manufacture of oil of vitriol. Bisulphide of carbon.

Chlorine. Hydrochloric acid. Hypochlorous acid. Bleaching agents and theory of bleaching. Chloric acid and perchloric acid. Chloride of nitrogen. Chlorides of carbon.

Bromine. Hydrobromic acid and bromic acid.

Iodine. Hydriodic acid. Iodic acid, periodic acid.

Fluorine. Hydrofluoric acid.

Nitrogen. Ammonia. The oxides of nitrogen.

Phosphorus. Phosphoretted hydrogen. Hypophosphorous acid, phosphorous acid. The several modifications of phosphoric acid: ordinary phosphoric, pyrophosphoric, and metaphosphoric acids. Theory of polybasic acids. Chlorides of phosphorus. Manufacture of matches.

Carbon. Marsh gas. Carbonic oxide. Carbonic acid. Olefiant gas. Manufacture of coal gas. Nature of flame.

Silicium. Silicietted hydrogen and silicic acid. Hydrofluosilicic acid.

Boron and boracic acid.

The metals: **Potassium.** Manufacture of nitre. Manufacture of gunpowder. Theory of the action of gunpowder. **Sodium.** Manufacture of soda.

Barium. **Strontium.** **Calcium.** Mortars.

Spectrum analysis; its principles and applications.

Magnesium, **Aluminium.** Manufacture of glass and porcelain.

Manganese. **Iron.** Composition and properties of cast iron, wrought iron, and steel.

Cobalt. **Nickel.** **Chromium.** **Zinc.** **Cadmium.** **Copper.** **Lead.** Manufacture of white lead.

Bismuth. **Mercury.** **Tin.** **Arsenic.** Course of analysis in cases of poisoning.

Antimony. **Silver.** **Gold,** and **platinum.** Principal compounds of the metals with the non-metallic elements.

Outline of qualitative analysis. Reactions of the principal mineral acids and bases. Course pursued in the application of these reactions to the analysis of a mixture of several acids and bases.

The following is a list of Apparatus and Re-agents which Candidates will find useful in analysis:—

APPARATUS.

Test tubes and stand.	Iron spoon.	Platinum wire and foil.
Metal filter stand.	Tongs.	Funnels.
Wash bottle containing distilled water.	Pestle and mortar.	Cut filters.
Spirit lamp.	Porcelain dishes.	Sulphuretted hydrogen apparatus.
Black blowpipe.	Watch glasses.	Platinum crucible.
Charcoal for blowpipe experiments.	Porcelain crucible.	Herapath's blowpipe.
	Triangles.	Stirring rods.
	Test tube cleaner.	

RE-AGENTS.

In the liquid state.

Sulphuric acid.	Ammonium, oxalate.	Acetic acid.
Hydrochloric acid.	Sodium, phosphate.	Hydrofluosilicic acid.
Nitric acid.	Barium, chloride.	Lead, acetate.
Hydrosulphuric acid.	Calcium, chloride.	Iron, sesquichloride.
Potassa.	Lime water.	Potassium, ferrocya-
Ammonia.	Calcium, sulphate.	nide.
Ammonium, chloride.	Potassium, sulphate.	Potassium, sulpho-
Ammonium, sulphide.	Magnesium, sulphate.	cyanide.
Ammonium, carbonate.	Potassium, chromate.	Platinum, chloride.
Ammonium, molyb-	Oxalic acid.	Silver, nitrate.
date.	Tartaric acid.	

In the solid state.

Sodium, carbonate.	Borax.	Blue and red litmus
Potassium, nitrate.	Lime.	paper.
Potassium, cyanide.	Iron, sulphate.	

Subject XI.—Organic Chemistry.

Definition of organic bodies. Their ultimate analysis. Calculation of an empirical formula. Methods of controlling an empirical formula. Determination of the molecular weights of organic acids and bases. Determination of the vapour-density of volatile bodies. Law of substitution. Synthesis of organic compounds.

The chemical history of the Cyanogen group. Cyanogen. Hydrocyanic acid. Cyanic acid and urea. Fulminates. Cyanuric acid. Sulphocyanic acid. Chlorides of cyanogen.

Amylaceous and saccharine substances. Fermentation. Alcohol, and its homologues. Ethers, simple and mixed. Oxidation of alcohol, Aldehyde and acetic acid, and their homologues. Chloride of acetyl. Anhydrides, simple and mixed. Compound ethers. Diatomic alcohols and their acids. Glycol and oxalic acid. Triatomic alcohols. Glycerine. Fatty and oily bodies.

Tartaric and citric acids. Tannic acid.

Aromatic bodies. Benzoic alcohol, aldehyde, and acid; their derivatives, their homologues. Salicylous and salicylic acid. Gallic and cinnamic acid. Hippuric acid.

Ammonia and its derivatives. Amides and amines: their classification. Examples of natural alkaloids.

Principal colouring matters. Indigo and its derivatives. Examples of products formed by destructive distillation. Colours derived from coal tar.

The chief constituents of the vegetable and animal organism, fibrin, albumen, casein, &c.

The chemical principles of agriculture.

The chemical principles of the process of nutrition and respiration in the animal organism.

Text-books.—Graham's *Elements of Chemistry*, Miller's *Elements of Chemistry*, Fownes' *Manual of Chemistry*, Bloxam's *Chemistry, Inorganic and Organic*, Galloway's *First and Second Steps in Chemistry*, Williamson's *Chemistry for Students*, Frankland's *Lecture Notes*, Roscoe's *Lessons in Elementary Chemistry*.

Subject XII.—Geology.*General Principles.*

1. The division of rocks into three great classes, aqueous, igneous, and metamorphic.
2. The mode of formation of stratified rocks, such as ordinary marine strata of shales, sandstones, conglomerates and limestones

—delta formations—freshwater and terrestrial beds, and the signs by which you can distinguish these, such as the nature and mode of the occurrence of the genera of animals and plants that are found in them.

3. The theories of central heat, and of the consolidation of the earth from a state of igneous fusion.
4. The mode of occurrence of igneous rocks, intrusive bosses, lavas, volcanic ashes, and dykes.
5. Volcanoes and volcanic phenomena; the origin of volcanoes and the cause of eruptions.
6. Elevation and depression of land; the distribution and origin of mountain chains. Denudation of the earth's surface, origin of valleys, &c.
7. The ordinary mineral substances that enter into the composition of rocks, such as granites, diorites, basalts, &c. Gneissic rocks, sandstones, slates, shales, clays, &c. The origin of limestones. The origin of mineral veins or lodes.
8. Fossilization of organic bodies.
9. Table of geological formations, including those larger divisions absent in Britain.
10. Theory of metamorphism of rocks. Origin of cleavage.
11. Explanation of geological terms.
12. Definition of zoological terms used in geology, such as genus, species, bivalve and univalve shells, cephalopod, brachiopod, palæozoic, &c. &c.
13. The meaning of breaks in the succession of life (changes of genera and species) in the different formations.

Stratified Formations, &c.

1. Description of the Cambrian and Silurian strata, their physical characters, fossils, and any unconformities that exist in the British Silurian strata.
2. Description of the Old red sandstone and Devonian rocks, characters and fossils. Slate and slate quarries, building-stones, limestones, and marbles of these and the Silurian formations.
3. The Carboniferous limestone and Coal-measure series. Character, fossils, and mode of formation. Nature of the plants of the Coal-measure epoch. Their mode of growth. Origin of coal, its mode of occurrence, and how the vegetable matter became changed into coal. Mode of occurrence of the ironstone of the Coal-measures. Various kinds of coal, and the relation of anthracite coal to disturbance of strata. Limestone quarries, marbles, and building-stones. Clay pits and potteries of the Carboniferous strata. Fire clay. Alum shale, &c.
4. The Permian rocks. Their stratigraphical relations to the underlying strata, composition of rocks, fossils, and building-stones. Great break in the succession of life between the Palæozoic and Mesozoic or secondary strata.
5. The New red sandstone (or Trias), its subdivisions, fossils, building-stones, sand pits. Origin of rock salt and brine springs.
6. The Rhetic beds and Lias, their subdivisions, fossils, building-stones and hydraulic limestones, and clay pits.
7. Oolitic rocks. Subdivisions, leading marine and land fossils. Limestones, clay pits, coal, jet and other economic products.
8. The Purbeck and Wealden strata. Origin, subdivisions, chief fossils, building-stones, and marbles. Ironstones and limestones. Clays. Great break in the succession of marine fossils between the Oolitic and Cretaceous strata.
9. Cretaceous rocks. Subdivisions, lithological characters, fossils building stones of Lower Greensand. Gault, its phosphatic nodules

- and general uses. Upper greensand, chalk, &c. Building stones. Origin and uses of chalk-flints. Great break in the succession of marine fossils between cretaceous and eocene strata.
10. Eocene, or older Tertiary beds. Subdivisions, alternation of marine and freshwater beds, chief fossils, limestones and building stones, clays for bricks and potteries.
 11. Miocene or middle tertiary strata, marine and freshwater, fossils, &c.
 12. Crag. Its subdivisions, chief fossils. Origin of its phosphatic remains.
 13. The glacial period, boulderclay, and evidence of old glaciers in Britain, &c. River gravels, &c. of post-tertiary age, and their contents.
 14. Disturbance and denudation of strata in successive periods, &c.
 15. Unconformities, faults, and fractures.
 16. The causes of gaps in the succession of strata, or of breaks in the succession of life in time.
 17. Water-bearing strata, and underground drainage. Artesian and other wells.
 18. British rocks in which ores of metal are found, and the general mode of occurrence of these ores in beds of solid rock, in superficial detritus and in lodes.
 19. The rules that ought to guide the miner in sinking for coal and other minerals, when the beds in which they lie are concealed by over-lying and unconformable strata.
- Text-books.—Lyell's *Principles of Geology*; Lyell's *Elements of Geology*; Phillips' *Manual of Geology*; Jukes' *Manual of Geology*; Juke's *Geology for Schools*; Page's *Introductory Text-Book*; Page's *Advanced Text-Book*; Ramsay's *Physical Geology and Geography of Great Britain*; Woodward's *Recent and Fossil Genera of Shells*.

Subject XIII.—Mineralogy.

- A. Instruction in this subject should commence with a distinct understanding of the characters by which minerals, properly so called, are to be distinguished from other inorganic substances, and of the position of this science in relation to the collateral sciences of physics, chemistry, and geology.
- B. Crystallography, as the essential means of appreciating the forms naturally assumed by almost all inorganic bodies, must commence with the needful geometrical definitions, proceed to the grouping of the various crystalline forms into systems, consider the laws by which the derivation of one form from another within the limits of the same system is determined, and explain the combination of various simple forms in the faces exhibited by compound crystals. It is also important to study the deviations from regularity which are commonly presented in nature, and the methods of measuring those elements which remain constant.
- C. The various kinds of aggregation exhibited by crystalline substances are also to be considered, especially with reference to masses of the useful minerals, and of crystalline rocks.
- D. Next in order will follow the other physical characters of minerals; 1st, in relation to their substance, as cleavage, fracture, hardness, and specific gravity; 2ndly, in relation to the effects of light, as transparency, refraction, lustre, and colour; 3rdly, as to their electric and magnetic properties.
- E. The chemical characters of minerals, and the most convenient modes of testing them; 1st, by aid of the blowpipe; 2ndly, by the moist way.
- F. Pseudomorphism, or the remarkable phenomena presented by minerals which have the composition of one mineral coupled with the form of another.

- g. The physiography or systematic description of minerals. This last division should include all the more remarkable varieties as well as species, and should take especial note of the modes and places of occurrence, as well as of the association of particular groups of minerals in certain veins or formations.

As text-books may be recommended—

Professor Ansted's *Elementary Course of Mineralogy and Geology*. London. 1856.

Nicol's *Elements of Mineralogy*. Edinburgh, 1858.

Dana's *Manual of Mineralogy*, 1851.

Bristow's *Dictionary of Minerals*. Longman & Co. 1861.

For more advanced students—

Brooke and Miller's *Mineralogy*. London, Longman, 1852.

On Crystallography. Rev. W. Mitchell, in Orr's "*Circle of the Sciences*." London, 1856.

Dana's *System of Mineralogy*. 4th edition. Putnam, 1854.

Naumann's *Mineralogie*. Leipzig. Williams and Norgate, London.

Breithaupt's *Paragenesis der Mineralien*. Freiberg, 1849.

Haidinger's *Handbuch der Mineralogie*. Vienna, 1845.

When it is intended to teach this subject with special reference to the practical working of minerals, the physiographical part will be occupied more particularly with certain of the useful species and their associated substances, and the following works may be consulted :—

W. J. Henwood on the *Metalliferous Deposits of Cornwall and Devon*, 1843.

Bischof, *Chemical and Physical Geology*, translated by the Cavendish Society. 1854.

Subject XIV.—Animal Physiology.

Candidates must be prepared to answer questions upon the following points in Human Anatomy and Physiology :—

The plan of the human body and the arrangement of its parts.

The meaning of the terms organ and tissue.

The general structure and disposition of the principal organs and tissues.

The ultimate chemical composition of air, water, carbonic acid, urea ; of protein, fat, starch, and sugar ; of bone-earth and horn.

The meaning of the term function.

The general working of the body considered as an engine ; its waste, and the mode in which that waste is made good.

The particular functions of the different organs.

The structure and working of the heart and blood vessels.

The nature of the lymphatics and lacteals.

The course of the circulation of the blood, and the evidence that it circulates.

The pulse and the sounds of the heart.

The regulation of the circulation by the nervous system.

The structure and properties of blood corpuscles.

The process of the coagulation of the blood.

The proximate chemical constituents of the blood, and the uses of that fluid.

The difference between arterial and venous blood. The way in which that difference is brought about. The working of the chest and lungs in respiration.

The difference in chemical composition between inspired and expired air. The daily loss of carbon and gain of oxygen. Stationary and tidal air.

The respiratory murmurs. The nature of asphyxia, and the necessity for fresh air.

The structure and uses of the kidneys. The daily loss of nitrogen in the shape of urea, of uric acid and of saline matters, by the kidneys.

The structure and uses of the skin.

The relations of the lungs, skin, and kidneys.

The structure and uses of the liver. The nature of the bile.

The development, distribution, and regulation of the heat of the body.

The composition of aliments: proteids, fats, amyloids, and minerals.

Essential and accessory alimentary substances. Economy of a mixed diet.

The digestion and absorption of aliments.

Cilia and muscles; their structure and properties. The levers of the body. The structure of joints. Locomotion.

The structure and working of the larynx. Voice and speech.

The muscular sense. The organs of the higher senses, touch, taste, smell, hearing, and sight, and the manner in which they intermediate between the cause of the sensation and the expansion of the nerve. The adjustment of the eye to distances. The theory of the stereoscope.

Simple and compound sensations.

Auditory and ocular spectra. Auditory and optical delusions.

The general structure of the nervous system. The properties of nerves, and of the spinal cord, brain, and sympathetic. Vasomotor nerves.

Reflex actions, natural and acquired.

Text-books for Physiology.—Carpenter's *Animal Physiology*; Kirke's *Manual*; Huxley's *Lessons in Elementary Physiology*.

Subject XV.—Zoology.

1. Candidates should have carefully mastered the definitions of the *sub-kingdoms*, *classes*, and *orders* of the Animal Kingdom. They should understand and be able to explain the meaning of the terms employed in such definitions; and they should be able to refer any specimens that may be placed before them to their proper *classes*.
2. Candidates should be prepared to give fair answers to questions relating to any or all of the following subjects, and they should be able to identify, refer to their proper orders, and if called upon to do so, describe, the objects enumerated in each section under the head of "types." In almost all cases these "types" are British animals.

By the term Natural History, of such and such an object, is meant such an account of it as is to be found in any standard modern work on Zoology.

i. The structure and mode of multiplication of infusorial animalcules and *Foraminifera*. The arguments which have been adduced for and against spontaneous generation. The luminosity of the sea, and the nature of the creatures which chiefly cause it. The natural history of the sponge of commerce. Types—*Spongia*, *Vorticella*.

ii. The meaning of the terms, zoophyte, coral, coralline. Natural history of the red coral of commerce. Common coral and coral reefs. What such reefs are, where they are formed, and how they grow. Natural history of the common freshwater polype, or hydra, and of the "jelly fishes," or "medusæ" of the sea. A sexual multiplication as exhibited by these creatures. Types—*Hydra*, *Sertularia*, *Plumularia*, *Actinia*, *Corallium*, *Fungia*, *Oculina*.

iii. Starfishes, sea urchins, and *Holothuræ*; their structure and habits, and the metamorphoses which they undergo. Natural and economical history of Trepan. Types—*Uraster*, *Echinus*.

iv. Natural history of the earthworm and the leech. Intestinal worms; their structure, propagation, and mode of entrance into animal bodies. Natural history of the *Rotifera*. Types—*Lambrius*, *Hirudo*, *Distoma*, *Tania*, *Ascaris*.

v. Natural history of *Crustacea*. The lobster and crayfish, as exemplifying morphological and teleological laws. The process of ecdysis. Barnacles, acorn shells, and fish lice, as cases of extreme metamorphosis. The water flea as exemplifying asexual multiplication. Types—*Cancer*, *Homarus*, *Astacus*, *Oniscus*, *Daphnia*, *Cyclops*, *Lepas*, *Balanus*, *Argulus*.

vi. Natural history of spiders, scorpions, and mites. The "itch insect," centipedes, and millipedes. Types—*Tegenaria*, *Scorpio*, *Scolopendra*, *Julus*.

vii. Insects; their mode of breathing as contrasted with that of spiders and crustaceans. The structure of their wings, and the mechanism of flight. The parts of the mouth and their modifications in beetles, bees, butterflies, bugs, and gnats. Structure of the eyes. Nature of stings, saws, and ovipositors. Natural and economic history of the blistering beetle, of the silk moth, of the bee, of the cochineal insect. Natural history of plant lice, of bugs, fleas, and lice. The house fly, blow fly, and gnat; wasps, humble bee, ichneumon flies; "black beetles," crickets, and locusts. The metamorphoses of insects. Types—*Melolontha*, *Blatta*, *Libellula*, *Phryganea*, *Coccus*, *Aphis*, *Bombyx*, *Apis*, *Vespa*, *Musca*.

viii. The characteristic peculiarities of the nervous, circulatory, respiratory, and locomotive organs of mollusks in general. Organization of "sea mat" (*Flustra*). Ascidians and "lamp shells" (*Terebratula*). Natural history of fresh-water and marine mussels. Nature of mother of pearl. Formation of pearls. Pearl fishery. Natural and economical history of the oyster. Organization of snails and slugs, periwinkles, limpets, whelks. Development of the young of the latter. Nidamental capsules. Cuttlefishes and squids. Paper nautilus. Pearly nautilus. The shipworm and *Pholas*. Mechanism by which mollusks bore. Types—*Flustra*, *Ascidia*, *Terebratula*, *Unio*, *Mytilus*, *Ostrea*, *Pecten*, *Helix*, *Patella*, *Littorina*, *Buccinum*, *Chiton*, *Sepia*, *Loligo*, *Argonauta*, *Nautilus*.

ix. Circulatory, respiratory, and reproductive organs of fishes. Their dentition. Natural and economical history of the lamprey, sprat, sardine, herring, pilchard, salmon, trout, eel, cod, haddock, sole, flounder, turbot, mackerel, tunny, sturgeon, skate, ray, dog fish, shark. Electrical fishes. Fishes which are capable of living in air. Pisciculture, or the artificial breeding of fishes. Types—*Amphioxus*, *Petromyzon*, *Syngnathus*, *Cyprinus*, *Perca*, *Accipenser*, *Lepidosteus*, *Raia*, *Spinax*.

x. Natural history of salamanders, newts, frogs, and toads, Metamorphoses undergone by their young. Types—*Salamandra*, *Triton*, *Rana*.

xi. Circulatory and respiratory organs of reptiles as distinguished from those of fishes and amphibia. Natural history of snakes, lizards, crocodiles, turtles, and tortoises. Tortoise-shell. Shedding of the skin in reptiles. Types—*Coluber*, *Pelias*, *Anguis*, *Lacerta*, *Crocodilus*, *Testudo*, *Chelone*.

xii. Organs of locomotion, respiration, voice, circulation, and reproduction of birds. Structure and mode of growth of feathers,

Development of the fowl's egg. Artificial hatching. Migration, and instincts of birds. Natural history of domestic birds; of the ostrich, the apteryx, the penguin, and the dodo. Types—*Falco*, *Corvus*, *Columba*, *Picus*, *Phasianus*, *Ardea*, *Struthio*, *Anser*.

xiii. Organs of respiration, circulation, and reproduction of mammals. Production and nutrition of their young. Placental and implantal mammals. Nature of milk and of the lacteal glands. Peculiarities in the dentition of mammals. Natural and economic history of the domestic mammals; of the ivory and fur yielding mammals; of seals; of whales. The hybernation and migration of mammals. Characters of the orders of mammals. Types—*Cercopithecus*, *Vespertilio*, *Erinaceus*, *Lepus*, *Elephas*, *Sus*, *Cervus*, *Bos*, *Ovis*, *Felis*, *Phoca*, *Phocæna*, *Dasypus*, *Halmaturus*, *Ornithorhynchus*.

xiv. The distinctive peculiarities of man. The characters of the principal races of mankind, and their geographical distribution.

Text-books for Zoology.—Dallas's *Natural History of Animals* in Orr's *Circle of the Sciences*; Gosse's *Manual of Marine Zoology*; Professor Greene's *Manual of the Protozoa*; Rymer Jones's *Animal Kingdom*.

Subject XVI.—Vegetable Physiology and Economic Botany.

In this department the candidate will be expected to answer correctly questions on the following points:—

1. The properties of the principal elements entering into the composition of plants. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, chlorine, iodine, silicon, potassium, sodium, calcium, iron.
2. The composition and properties of the compounds forming the principal part of the structure of plants. Cellulose, starch, dextrine, sugar, fixed oil, gluten, albumen, caseine. The saline compounds forming the ashes of plants.
3. The composition and properties of peculiar vegetable products. Volatile oils. Acids. Colouring matters. Alkaloids. Neutral principles. Chlorophyll.
4. The origin and growth of the vegetable cell. The tissues of plants. Cellular tissue. Intercellular organs. Epidermal tissue. Hairs. Stomates. Vascular tissue. Woody tissue.
5. The structure and functions of the organs of plants. The root. Spongioles. Absorption and excretion. Nature of vegetable food. The stem. Structure of Exogenous, Endogenous, and Acrogenous stems. The leaf. The forms of leaves. Exhalation. Stipules and bracts. The flower. Calycine, Corolla, Staminal, and Carpellary leaves. Development and nature of pollen. Ovules or seed buds. Vegetable impregnation. Embryo. Seed. Fruits; their nature and forms. The nature of the reproductive organs in flowerless plants.
6. The composition and nature of vegetable substances used by man as food. Distinctions between heat-giving and flesh-forming foods. Structure and geographical distribution of plants yielding starch, sugar, oil, gluten, albumen, and legumin.
7. Properties of vegetable substances used in the arts and manufactures. Vegetable secretions used as dyes.—Indigo, madder, logwood, red sanders wood, quercitron, alkanet, arnotto, gall-nuts, myrobolans.
8. Materials used in the manufacture of textile fabrics.—Cotton, flax, hemp, coco-nut, jute, New Zealand flax.
9. Principal forms of timber trees, and their uses.—Oak, mahogany, teak, pine, &c.
10. Nature of tanning principles and plants yielding tannic acid.—Oak-bark, valonia, catechu, kino, divi-divi, betel-nut.

11. Gums, oils, and resins used in arts.—Gum arabic, benzoin, rosin, turpentine, camphor, essential oils, coco-nut oil, palm oil, other fixed oils, caoutchouc, gutta pertsha.
12. Substances obtained from the vegetable kingdom and used as medicines.—Opium, quinine, tobacco, jalap, scammony, gentian, aloes, rhubarb, senna, ipecacuanha, sarsaparilla, castor-oil, assafoetida, myrrh, nux vomica, hemlock.

Text-books for Vegetable Physiology and Economic Botany.—Hefrey's *Elementary Course of Botany*; Van Voorst. Carpenter's *Vegetable Physiology*, edited by Dr. Lankester; Bohn. Schleiden's *Principles of Scientific Botany*; Bohn. *A Manual of Structural Botany* by M. C. Cooke. Archer's *Popular Economic Botany*; Reeve and Co. Lindley's *Medical and Economical Botany*; Bradbury and Evans.

Subject XVII.—Systematic Botany.

In this department the candidate will be expected to demonstrate the structure of plants from living specimens.

1. The distinctions between the three great classes of plants, Dicotyledons, Monocotyledons, and Acotyledons. Also of the groups Gymnosperms, Rhizanth, Dictyogens, Acrogens, and Thallogens.
2. The characters of the following orders of British plants should be mastered, and the typical genera recognized, and their structure understood.
3. *Alge*. The natural history and uses of sea-weeds. The microscopic structure of diatoms and desmids. Nature of the reproductive organs in this order. Types—*Navicula*, *Desmidium*, *Conferva*, *Fucus*, *Ceramium*.
4. *Lichens*. The natural history and uses of lichens. Structure of their reproductive organs. Types—*Graphis*, *Collema*, *Parmelia*.
5. *Fungi*. The natural history of mushrooms, puff-balls, moulds, blights, and toadstools. Their uses in nature. Types—*Agaricus*, *Bovista*, *Torula*, *Aspergillus*, *Morchella*, *Mucor*.
6. *Mosses*. The nature of their reproductive organs. Types—*Bryum*, *Sphagnum*, *Funaria*.
7. *Ferns*. Nature of their rhizomes. Herbaceous and tree ferns. History of Development, and nature of reproductive organs. Types—*Polypodium*, *Hymenophyllum*, *Osmunda*.
8. *Graminaceæ*. The history of grasses and their uses. Nature of the flower in this order. Useful plants of the order. Types—*Pheum*, *Hydrochloa*, *Panicum*, *Agrostis*, *Arunido*, *Spartina*, *Avena*, *Festuca*, *Hordeum*, *Triticum*, *Secale*, *Nardus*, *Anatherum*.
9. *Cyperaceæ*. Sedges. Types—*Carex*, *Scirpus*.
10. *Liliaceæ*. The lily tribe, its useful properties. Types—*Tulipa*, *Ornithogalum*, *Muscari*.
11. *Amaryllidaceæ*. The family of the narcissus, snow-drop, snow-flake. Types—*Narcissus*, *Galanthus*.
12. *Orchidaceæ*. The orchis family. Structure of reproductive organs. Types—*Orchis*, *Goodyera*, *Malaxis*, *Cypripedium*.
13. *Amentaceæ*. The family of the hazel, chestnut, oak, willow, birch, beech, poplar, and hornbeam. The uses of these plants as timber, &c. Types—*Quercus*, *Corylus*, *Fagus*, *Castanea*, *Betula*, *Myrica*, *Salix*, *Populus*.
14. *Urticaceæ*. The nettle and hop tribe. Its relations to *Moraceæ*, *Artocarpacæ*, *Cannabinaceæ*, and *Ulmaceæ*. The nature of the stings of *Urtica*, and the bitter principle of the hop. Types—*Urtica*, *Parietaria*, *Humulus*.
15. *Euphorbiaceæ*. The spurge family. Foreign forms and their uses. *Croton*, *Cascarilla*, *Ricinus*, *Janipha*. Apetalous and Polypetalous forms. Types—*Euphorbia*, *Buxus*,

16. *Polygonaceæ*. The buckwheat and rhubarb tribe. Types—*Polygonum*, *Rumex*.
 17. *Primulaceæ*. The primrose family. Theory of the peculiar position of stamens. Types—*Primula*, *Lysimachia*.
 18. *Labiata*. The dead nettle tribe. Peculiar properties of this order. Types—*Mentha*, *Salvia*, *Thymus*, *Nepeta*, *Lamium*, *Teucrium*.
 19. *Scrophulariaceæ*. The scrophularia tribe. Nature of the poisonous properties of the order. Types—*Scrophularia*, *Digitalis*, *Verbascum*, *Euphrasia*, *Veronica*, *Melampyrum*.
 20. *Boraginaceæ*. The borage tribe. Peculiarities of their epidermis. Useful species. Types—*Cynoglossum*, *Borago*, *Echium*, *Myosotis*, *Lithospermum*.
 21. *Solanaceæ*. The tribe of deadly nightshade, henbane, tobacco, and potato. Useful and poisonous species. Types—*Solanum*, *Atropa*, *Hyoscyamus*, *Datura*.
 22. *Ericaceæ*. The heath tribe. Its distinction from *Epacridaceæ*. Types—*Erica*, *Arbutus*, *Vaccinium*, *Pyrola*, *Monotropa*.
 23. *Compositæ*. The composite family. The number of species and geographical distribution. Structure of the sub-orders *Asteraceæ*, *Cichoraceæ*, and *Cynaraceæ*. Types—*Tussilago*, *Aster*, *Inula*, *Gnaphalium*, *Bellis*, *Artemisia*, *Achillea*, *Carlina*, *Carduus*, *Cichorium*, *Leontodon*, *Lactuca*, *Crepis*.
 24. *Stellatæ*. The Stellate tribe. Its relation to *Cinchonaceæ* and *Caprifoliaceæ*. The properties and useful plants of *Cinchonaceæ*. Types—*Galium*, *Rubia*.
 25. *Umbelliferae*. Umbel bearing plants. Character of inflorescence and flowers. Nature of fruit. Structure of cremocarp. Properties of the order. Types—*Hydrocotyle*, *Sanicula*, *Eryngium*, *Apium*, *Sium*, *Æthusa*, *Eranthe*, *Crithmum*, *Angelica*, *Pastinaca*, *Daucus*, *Torilis*, *Scandix*, *Conium*, *Coriandrum*.
 26. *Cucurbitaceæ*. Melon, cucumber, and gourd family. Useful plants of this order. Type—*Bryonia*.
 27. *Rosaceæ*. The rose, apple, cherry, and plum tribe. Forms of the fruit. The useful plants of this order. Types—*Prunus*, *Spiræa*, *Fragaria*, *Rubus*, *Geum*, *Rosa*, *Cratægus*, *Pyrus*.
 28. *Leguminosæ*. The bean, pea, and clover family. Principal divisions of the family. Structure of the flowers and fruits. Useful plants of the order. Types—*Ulex*, *Trifolium*, *Vicia*, *Astragalus*, *Ornithopus*.
 29. *Cruciferae*. Cabbage, turnip, and mustard tribe. Structure of the flowers and fruits. Useful plants of the order. Properties. Types—*Nasturtium*, *Alharia*, *Brassica*, *Sinapis*, *Armoracia*, *Iberis*, *Isatis*, *Crambe*, *Cakile*.
 30. *Papaveraceæ*. The poppy tribe. Properties and mode of collecting opium. Nature of fruit. Types—*Papaver*, *Glaucium*, *Chelidonium*.
 31. *Ranunculaceæ*. The crow-foot tribe. Structure of abnormal genera; *Aconitum*, *Aquilegia*, and *Delphinium*. Nature of poison in order. Types—*Ranunculus*, *Clematis*, *Helleborus*, *Pæonia*, *Anemone*.
- Text-books for Systematic Botany.—Lindley's *Vegetable Kingdom*. For British Botany.—Bentham's *Handbook of the British Flora*, or Babington's *Manual of British Botany*.

Subject XVIII.—Mining.

The Art of Mining embraces so wide a field of study that equal practical proficiency in its various branches is not to be expected; but those who wish to gain a general knowledge of it may be recommended to direct their attention to the subjoined heads, viz.:

1. Geology and Mineralogy, more particularly those portions of the sciences which bear on the following subjects,—the nature and position

in the earth's crust of the useful minerals, the classes of rock with which they are severally associated, the special character of heaves, throws, troubles, and all kinds of dislocation; the particular differences between beds and lodes, and their minerals, and the chief features of irregular repositories.

2. The methods of prospecting and searching at surface for ores and other minerals.

3. Breaking of ground; the various implements employed, their form, dimensions, and weight; boring for shots; the various modes of firing charges. Heavy charges, how calculated and fired; rules for ensuring safety.

4. Deep boring, under what circumstances applicable,—apparatus for; description of varieties in use; lining of bore-holes.

5. Management and supervision; payment of men employed at mines, at surface and underground, varying in principle with the different classes of operation; reasons for tut-work or piece-work, and tribute or bing-tale under different circumstances. Calculations for cost of driving, sinking, tramming, &c.

6. Physical principles of ventilation; practice of mines where simple natural ventilation is employed; ventilation of large areas and of deep or complicated workings by guiding the natural current; artificial means, and their details, for promoting ventilation. Precautions to be taken under specially dangerous conditions.

7. Illumination, of various kinds, their economy; safety lamps in all their best modifications; circumstances under which they should be employed; precautions in their use.

8. Mechanical division of the subject. Strength of materials used in mines; human and horse power, principles and construction of machines to which they are applied. Hydraulic machines: construction of the water-wheels, turbines, and pressure engines most suitable to the various operations of mining. Steam engines, for pumping and for winding; arrangement and construction of the varieties most in use. Form and dimensions of boilers. Pumps employed in mines, mode of placing them; construction of the lifts; materials and details of the rods, set-offs, counterbalances, cisterns, and catches. Circumstances under which dams are erected in shafts or levels; mode of building them.

Tubbing of water from shafts; conditions under which it may be done; details of the operation with various materials, wood, brick, stone, cast and wrought iron.

Rails, waggons, and tubs for underground conveyance; employment of horses and of fixed steam engines for this purpose.

Raising of the mineral through the shafts; various methods in use; chains, ropes (of hemp or wire), their weight, &c. Details of the best application of drums, cages, guides, keeps, and safety doors. Pulleys and shaft frames or poppet heads; protection against over-winding; safety clutches, &c. in case of breakage of rope.

9. Opening of ground; quarries and open work; driving of levels, various dimensions and directions according to circumstances; sinking of shafts, inclined or perpendicular; advantages of either kind under certain conditions; means of securing levels and shafts by timber or by walling; details of the various methods. Driving or sinking in heavy or running ground.

10. Working excavations; plan of laying them out, and means of security to be adopted whilst they are kept open. This will include the stoping of metalliferous veins, and the various modifications of post and stall, long-work, &c., which are applied to stratified deposits,

11. Travelling in shafts; prevention of accidents by proper fitting and dividing; mode of placing ladders and sollars; lifting machine for men, construction and advantages of.

12. Dressing of minerals. Arrangement of dressing floors. Construction of crusher and stamps; washing of coal; jigging, concentration, and separation of metallic minerals.

The student may be advised among other sources of information to consult the following works:—

De la Beche's *Report on Cornwall and Devon*. Greenwell's *Treatise on Mine-Engineering*. Dunn on the *Winning and Working of Collieries*. Hedley on *Colliery Working and Ventilation*. Smyth's *Rudimentary Coal and Coal Mining*. Evidence before Committees of the Houses of Lords and Commons on *Accidents in Mines*. Reports of H.M. Inspectors of Coal Mines. Transactions of the Northern Institute of Mining Engineers.

Subject XIX.—Metallurgy.

I. Introduction.

On certain physical properties of metals. Action of heat, specific gravity, crystallization, fracture, malleability, ductility, tenacity, conductivity of heat and electricity, opacity, lustre, colour. General considerations on metallurgical processes. Modes of occurrence of metals in nature, ores, reduction, smelting, roasting, liquation, slags.

II. Fuel.

General remarks, calorific power, calorific intensity, classification of fuels, wood, peat, lignite, coal, charcoal, coke, gaseous fuel and gas furnaces, charcoal burning, coke burning, typical varieties of coke ovens, comparison of fuels with respect to calorific power. This important branch of the subject is treated with much detail.

III. Refractory materials employed in the construction of furnaces, crucibles, &c.

Fire-clays British and foreign, crucibles of various kinds, plumbago and its application to crucibles, manufacture of crucibles, fire-bricks, silica and its applications, Dinas fire-bricks, sand and sandstones.

IV. Special Metallurgy.

Copper.—Compounds of special importance in the metallurgy of this metal fully described, such as the disulphide, oxides, &c., ores of copper, copper-smelting in reverberatory and blast furnaces, reactions occurring in the process, kernel-roasting, 'wet' methods, of extracting copper from its ores, assaying of copper ores by 'dry' and 'wet' methods, ship sheathing.

Zinc.—In describing the metallurgy of zinc and the following metals, the same plan will be followed as in describing the metallurgy of copper, that is to say, the compounds of special metallurgical importance will be first considered in detail, as well as the reactions upon which the various processes of smelting essentially depend, and the construction of the furnaces will be fully explained. Ores of zinc, English, Belgian, Silesian, and Carinthian methods of extraction, assaying of zinc ores brass, its history, properties and manufacture.

Lead.—Ores of lead, lead smelting in the 'ore-hearth,' low blast and reverberatory furnaces, lead-fume and various methods adopted for its condensation, assaying of lead ores.

Silver.—Ores of silver; smelting of silver ores with lead; cupellation; desilverization of lead by Pattinson's process, also by that of Parkes;

treatment of argentiferous copper by liquation; extraction of silver; amalgamation, the old Freiberg method and the Mexican; Ziervogel and Augustin's 'wet' methods; treatment of argentiferous copper-regulus; alloys of silver and copper; standard silver; assaying of silver ores and alloys.

Gold.—Modes of occurrence of gold in nature; extraction by amalgamation and by smelting with lead; chlorine-water as a solvent for the extraction of gold from certain ores; separation of gold from silver or parting by nitric and by sulphuric acids; alloys of gold with the preceding metals; standard alloys; assaying of auriferous ores and alloys.

Mercury.—Ores of mercury; extraction in the Almaden, Idrian; and Hühner furnaces; in retorts in admixture with reducing agents; assaying of the ores of mercury.

Antimony.—Ores of antimony; liquation of the native sulphide and its subsequent reduction by iron or other agents; alloys of antimony, type metal, &c.; assaying of the ores of antimony.

Bismuth.—Mode of occurrence in nature; its extraction from ores containing it by liquation; alloys of bismuth.

Nickel.—Ores of nickel; modes of extraction, generally by a combination of 'dry' and 'wet' processes; alloys of nickel, especially those known as German silver; assaying of nickeliferous ores and alloys.

Cobalt.—Ores of cobalt; smelting and preparation of zaffre and cobalt colours, smalts, &c.; separation of nickel; assaying of cobalt ores.

Arsenic.—Mode of occurrence in nature; arsenious acid or 'glass' of arsenic, generally obtained as a secondary product in the treatment of certain other ores, such as those of nickel, cobalt, &c.; modes of condensation of arsenical fumes; preparations of arsenical 'glass.'

Tin.—Ores of tin; smelting in reverberatory and blast furnaces; tin refining; varieties of tin in commerce; alloys of tin, with the preceding metals, bronze, gun-metal, bell-metal, &c.; assaying of tin-ores.

Iron.—Malleable iron; steel; pig-iron; ores of iron, direct extraction of iron in the malleable state from the ore; smelting of iron in the modern-blast furnace; construction of blast-furnaces and blowing machines; economic application of the waste gases; conversion of pig into bar iron in open hearths and in the reverberatory furnace; manufacture of steel by various methods. This department of the subject will be treated at considerable length.

Various Metals.—Platinum and its associated metals; cadmium; sodium; aluminium; tungsten; titanium; manganese.

Subject XX.—Navigation.

1. **Elementary Principles.**—Problems relating to latitude, longitude, differences of latitude, and differences of longitude.

Relation between an arc of a parallel of latitude and an arc of the equator. Principles of plane sailing and middle latitude sailing. Principles of Mercator's sailing. Mercator's chart. Principles of great circle sailing. The compass and its corrections.

(1.) Variation. (2.) Deviation. (3.) Local attraction. (4.) General theory of deviation (Towson's Practical Information, first 50 articles). Correction of courses for variation, deviation, and leeway. The log. Correction of estimated distances run for errors in the log line and glass. Plane sailing. Traverse sailing. Middle latitude sailing. Mercator's sailing, with examples.

To find difference of longitude made on a traverse. Sea journal. A day's work. Practice of great circle sailing. Circular arc sailing. Tides. Winds. Cyclones. To find bearing of a circular storm; veering of wind; heaving to; and sailing from centre of gale. Construction of tables of meridional parts.

Description and use of sextant, with the theory, adjustments, and errors.

For students.—To obtain a 5th class, as far as principles of plane sailing. The compass and correction of courses.

To obtain a 4th.—As far as Mercator's sailing, with examples.

For third, second, and first class Queen's prizes, a proportionate knowledge of the remainder.

Subject XXI.—Nautical Astronomy.

Definitions. Time, apparent, mean, sidereal, &c. Equation of time. To express interval of mean or sidereal time in parts of sidereal or mean time respectively. To convert arc into time, and conversely. To find Greenwich date. To take out right ascension of sun for a given mean Greenwich date.

Correction of altitudes. Dip. Parallax. Refraction. Augmentation of moon's semi-diameter. Reduction of altitude of a heavenly body observed at one place to what it would have been if observed at another. The chronometer and its use, error, and rate.

Latitude by meridian altitude of sun, and fixed star.

Latitude by meridian altitude of moon. To find Greenwich mean time of moon's meridian passage. To find semidiameter and horizontal parallax of moon for a given Greenwich date. To take out from Nautical Almanac moon's declination, &c.

To find local and Greenwich mean time of passage of a star over a given meridian on a given day. Latitude by altitude of sun, star, or moon *below* the pole and by pole star. Latitude by altitude of sun or other heavenly body *near* the meridian. Calculations of hour angles. Meridian distances. Right ascensions. Computations of time. Error and rate of chronometer. Computation of mean or apparent time at any place from observed altitude of a heavenly body. Longitude by chronometer. Error in hour angle from error in observed altitude. Variation of compass. Azimuth, altitudes, amplitudes, determination of true bearings. True azimuth from altitude of heavenly body and without observed altitude. True bearing of a point of land, &c., by observed angular distance from the sun. Variation of compass from observed amplitude of sun.

Deviation of compass, from Art. 50 to end of Towson's Practical Information. Sumner's method of finding longitude and latitude.

Method of double altitudes, Ivory's and direct. Error of chronometer by equal altitudes of sun and fixed star. To compute apparent altitude of a heavenly body when its true altitude is given.

Methods of clearing a lunar distance from the effects of parallax and refraction. To find Greenwich date corresponding to a given true lunar distance, &c. To find the altitudes when a lunar distance is taken from altitudes before and after taking the distance. To find the longitude by a lunar. Rate of chronometer by a lunar.

Obs.—In all the above problems the demonstration of the rules as well as *accurate* practical working is required.

For students.—To obtain a 5th class, a knowledge of the elementary principles, and finding latitude by meridian altitudes of a heavenly body.

To obtain a 4th, the above, with variation of compass from altitudes and azimuths, and rate of chronometer, and longitude by chronometer, is required.

For third, second, and first class Queen's prizes, a more or less accurate knowledge of the remainder.

Subject XXII.—Steam.

1. *General Properties of Steam.*—General effects of heat and cold, with practical applications of the principle. Law of expansion by heat not universal. Beneficial result of this anomaly. To ascertain the temperature of any substance. Pyrometer. Thermometer—Description—Graduation. Comparison of thermometers when differently graduated. Laws of cooling. Conduction. Conducting powers of bodies. Convection. Explanation of some natural phenomena by this law. Radiation. Radiating power of bodies. On what it depends. Land and sea breezes. Capacity for heat. Unit of caloric. Latent heat. Under what circumstances heat becomes latent. Heat sole agent in melting and vaporising bodies. Calorimeter. Sources of heat. Combustion. Temperature necessary for it. Boiling point. Temperature of elastic fluids. Vapour. Formation of dew. Distinction between vapour and steam. Boiling points of fresh and salt water. Distillation. High-pressure steam. Measure of steam by atmospheres. Steam when in contact and when not in contact with boiling water. Relation between pressure, density, and temperature of steam. Specific gravity of steam. Common, superheated and surcharged steam. Priming. Analysis of sea water.
2. *Steam Engine.*—General principles. Different kinds. Engines in use before Watt. Newcomen's engine. Its defects. Discoveries of Watt. Blowing through. Defects in atmospheric engines. Single acting and double acting engines. Expansion valve. Cornish—High-pressure or non-condensing engine. Marine steam engine. Different descriptions. Side-lever marine engine. Blow-valve. Stuffing boxes. Piston of steam cylinder. Working parts. Working of the slides, strap, gib, and cutter. Escape valve of cylinder. Parallel motion. Hall's condensers. Test cocks. Grease cocks. Grease cups of slides. Annular air-pump bucket. Annular delivery valve. Various kinds of slides. Cushioning. Lead. Lap, its effects. The eccentric. Throw and stops of ditto. To find the travel of the slide. Back-lash. Double eccentric. Throttle valve. Expansion valve and various kinds. Barometer or condenser gauge. Method of estimating pressure by it. Errors in this method, and correction of the same. Lubricators, &c. Number of engines in a steamer. Expansion cams and gear. Feed pumps. Bilge pumps. Modes of propulsion. Paddle wheels. Pitch, Reefing. Disconnexion and immersion of wheels. Brakes.—Modes of fitting. The screw propeller. Length, angle, pitch, slip, area of screw blade. Disconnecting and raising screw. Governors. Direct acting engines. Gorgon—Fairbairn's double cylinder, oscillating, trunk engines, &c. Engines for screw propellers. Direct acting, with and without multiplying gear. Oscillating horizontal and trunk engines. Double acting air-pump.
3. *Boilers.*—Description. Gear connected with them. Tubular boiler. Number of boilers. Steam chest. Safety valve. Waste. Steam funnel and drip pipe to steam gauge. Wash or dash plates. The funnel dampers. Reverse valve. Communication or stop valve. Blow-out cocks. Circulating pipes. Brine pumps. Brine valves. Refrigerators.
4. *Calculations.*—Methods of measuring efficiency of steam engines. Duty of an engine. Horse power. Mercantile or nominal horse power. Horse power from the evaporation in the boiler. De Pambour's theory. Velocity of maximum useful effect. To find evaporation of a condensing engine of given dimensions and horse power, the piston moving with a given velocity with and without

expansion. To find the pressure in cylinder, knowing the effective evaporation. To find the diameter of a cylinder to work at a certain speed, knowing the evaporation. To find the evaporation in the boiler, knowing the diameter and velocity of piston and pressure of steam in the cylinder with and without expansion. Same for locomotive, Watt's engines, &c.

The screw—to find its area. Angle of the helix or thread of the screw propeller—to find the pitch. The power exerted by a screw. How far slip depends on form and dimensions of the screw. Motion of paddle-wheels, &c. Consumption of fuel. Measure of locomotive performance of marine steam engines. To find the angle the crank has moved through when the piston is at a given distance from the top of the stroke. Amount of work developed by crank in a half-revolution—length of radius-bar in side lever engine. Work done in the up and down stroke of the air pump. The best temperature for the condenser of a steam engine. Qualities of fuel, &c.

5. *Practical working*.—Getting up steam. Mode of starting. Working engines at moorings. Priming—causes and remedies. Banking up and putting back fires, &c. Duties to machinery when under steam, boiler, fires, &c. Injection pipes. Kingston's valves. Leaks in engines. Bearings of engines. Expansive working. Management of fuel. Damages and repairs to boiler, &c., after accidents. Duties to engine, &c., on arriving in harbour.

6. *Indicator*.—The ends it fulfils. Description. Atmospheric line. Method of taking a diagram. The general configuration of diagram to be expected under various circumstances. The slide-diagram. Examination of Indicator-diagram when steam is throttled; when expansive gear alone used, and in other cases. To ascertain the horse-power of an engine by means of the indicator. To find quantity of water evaporated. Friction of steam engine without load. Diagram when there is no condensation. Diagram showing the relative motions of slide and piston at every point of the stroke.

Dynamometer. To find horse-power of engine by means of it.

The text books specially recommended are—*The Marine Steam Engine*, by Professor Main and Mr. Brown, R.N., Longmans and Co.; Main and Brown's *Indicator and Dynamometer*; De Pambour's *Theory of the Steam Engine*.

Subject XXIII.—Physical Geography.

The following very brief outline of the principal branches of this subject may be useful:—

- a. So much elementary astronomy as relates to the position of the earth in the solar system, its magnitude and rotation, and the influence of the sun and moon on terrestrial phenomena.
- b. So much of elementary physics and inorganic chemistry as includes the nature and mode of action of the physical forces and the composition of rocks.
- c. So much of elementary geology and mineralogy as includes a knowledge of the nature of rocks, their superposition, succession, and disturbances.
- d. So much of palæontology as includes a knowledge of the distribution of life in time.

- I. The distribution of land. Form of land, continental and insular. Elevation of land. Mountains. Plateaux or table-lands. Low plains. Valleys. Deltas. Grouping of islands.
- II. Phenomena of water. Oceans and inland seas. Composition and temperature of oceans. Movements of water. Tides and currents. Waves. Lakes. Rivers and river systems. Waterfalls. Circulation of water on the globe. Ice. Glaciers. Springs.
- III. Phenomena of the atmosphere; its nature and composition. Effects of heat on air. Winds. Periodic winds. Storms of various kinds. Electric storms. Magnetic storms. Effects of moisture in the air. Dew. Clouds and rain. Estimate of rain-fall. Climate and weather.
- IV. Volcanic and earthquake phenomena. Distribution of volcanoes. Volcanic groups. Nature of an eruption. Nature of earthquakes. Range of earthquakes. Statistics of earthquakes. Result of volcanic action and upheaval on the physical condition of the land.
- V. Distribution of vegetation on the globe in space, horizontal and vertical. Influence of climate and soil on natural groups of plants. Representative forms of plants. Range of cultivated plants.
- VI. Distribution of animals in space. Zones of height in the air and of depth in water. Corresponding forms of animal life in different zones or belts. Relation between parallels of latitude and zones of height or depth. Special distribution of certain classes and groups of animals.
- VII. Distribution of plants and animals in time.
- VIII. Ethnology. Families of the human race. Geographical limit of certain races. First introduction of the human family. Modification of the races of men. Influence of man on vegetation and on animals. Extinction of races by human influence. Influence of man on inorganic nature.

The text-books recommended are—

Ansted's Physical Geography (2nd edition); Johnston's smaller Physical Atlas; Maury's Physical Geography of the Sea (last edition).

**LIST of SCIENCE SCHOOLS, giving the NUMBER of STUDENTS
returned as under INSTRUCTION in MAY 1866 and
MAY 1867, and the NUMBER of PRIZES and MEDALS
obtained in MAY 1866 and MAY 1867.**

LIST OF SCIENCE SCHOOLS, giving the NUMBER OF STUDENTS returned as under INSTRUCTION in MAY 1866 and MAY 1867,
and the NUMBER OF PRIZES and MEDALS obtained in MAY 1866 and MAY 1867.

Schools established since May 1866 are in *Italics*.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1866.	1867.			1866.	1867.	1866.	1867.
ENGLAND.												
Abingdon	British Schoolroom.	Strange, W. A., D.D.	Davis, John	Gubb, Edwin J.	..	30	30	..	8	..	..	..
Accrington	Mechanics' Institution	Ingram, J.	Ratcliffe, Wm.	Gunn, W.	23	21	..	2	6	..	..	..
Alderley Edge	Day School Room	Consterdine, Rev. J. W.	Railton, G. W.	Jones, Thomas	21	14	..	7	4	8	..	..
Almondbury	King James' Grammar School.	Dyson, Edward	Jones, J. W.	{ Easther, Rev. A. } { Jarmain, George. }	20	28	8	..	2	..	..	..
Andover	Mechanics' Institution	Clarke, T. P.	Footner, Richd.	Marriott, J. T.	37	45	8	..	4	3	..	..
Arundel	Westeyan School	Rumney, Robt.	Latton, Thomas	Hurst, W.	..	10	10	..	15	2	..	..
Ashby-de-la-Zouch	Mutual Improvement Society's Rooms.	Smith, H. E.	Dalby, John	Gibson, G. H.	34	37	3	..	..	..	..	..
Ashton-under-Lyne	Mechanics' Institution	Mason, Hugh	Howorth, D. F.	Butterworth, T.	30	20	..	..	3	8	..	..
Bacup	Mechanics' Institution	Aitken, John	Newbigging, T.	{ Shore, T. W. } { Thornley, Geo. }	38	51	13	..	2	7	..	..
Banbury	British School	Harrison, W. R.	Cadbury, James	{ Beale, J. H. } { Owen, A. }	36	36	..	..	15	18	18.2B.	..
"	Science School	"	"	Beasley, T.	..	30	30	..	..	..	..	..
"	Laboratory	"	"	Breara, W.	..	10	10	..	..	..	..	..
Barnsley	St. John's School	Hamer, A. G.	Binder, Rev. W. J.	"	..	17	17	..	25	1B.	..	..
Birmingham	Midland Institute	Martineau, T.	Smith, Edwin	Woodward, C. J.	122	135	13	..	..	20	..	..
Birmingham	St. Barnabas' National School.	Winter, Rev. S. W.	Bembridge, E.	Bulphitt, W. T.	..	61	61	..	..	26	..	..
"	Metropolitan Railway Works, Salford.	Scovcroft, Rev. J. H.	Smith, David	Bickerton, A. W.	..	55	55	..	..	21	..	..
"	Clarendon Chambers	"	"	"	..	..	..	..	..	..	..	..
"	Westeyan Schools	"	"	"	..	..	..	..	..	..	..	..
"	St. Matthew's Schools, Dudley.	"	"	"	..	..	..	..	..	..	..	..
"	School of Art.	Cope, C. E.	Laundy, E.	Raimbach, D. W.	..	55	55	..	..	23	..	18.

Blackburn	-	Wesleyan School	-	Beads, Jas.	-	Parkinson, Giles	-	Laherwood, Thos.	-	11	13	2	3	2	..	..
Blackford	-	Mechanics' Institution	-	Hutchinson, R. H.	-	Hand, Thomas	-	Gunn, W.	-	20	16	..	4	..	..	..
Bodmin	-	Working Men's Club	-	Kincham, W. C.	-	Mekle, William	-	Payne, Jas. junr.	-	43	22	22	..	15	..	..
Bolton	-	Literary Institution	-	Stokes, H. S.	-	Phillips, Josias	-	Downing, S.	-	63	47	4	..	13	..	..
"	-	Bridge Street School	-	Cannon, W. W.	-	Marsden, Peter C.	-	Ward, T.	-	65	60	..	5	3	..	..
"	-	Independent Methodists' School.	-	Winterburn, Geo.	-	Vickers, James	-	Spriggs, C.	-	34	13	..	21	2	..	..
"	-	Science and Art School	-	Powell, Rev. Henry	-	Lowe, Rev. J.	-	Collins, John	-	31	108	137	..	27	..	..
"	-	Mechanics' Institute	-	Gadon, John	-	Barton, J.	-	Domani, Rev. J. G.	-	95	79	..	16	27	1 G. 3 B.	..
Breage	-	Cornwall	-	Pridmore, Rev. E. M.	-	Cunnack, E. J.	-	Spriggs, C.	-	..	12	12	..	11	..	..
Bristol	-	Trade School	-	Moseley, Rev. Canon	-	Wilkinson, J.	-	Foster, C. Le Neve	-	180	145	15	..	83	97	1 G., 2 F. 2 S., 1 S. 7 B., 2 B.
Bromsgrove	-	Literary and Mechanics' Institute	-	Collis, F. D.	-	Gibson, C. W.	-	Coomber, T.	-	..	48	48	..	7	..	..
Burnley	-	Church of England Literary Institute	-	Parker, Rev. A. T.	-	Briggs, Benjamin W.	-	Plant, E. C.	-	70	55	..	15	11	14	..
"	-	Carlton Road School	-	Ashworth, Thos.	-	Graham, John	-	Ward, T. W.	-	62	69	7	..	4	..	..
"	-	Wesgate School	-	Massey, Lord	-	Massey, J.	-	Clement, Leonard	-	20	12	..	8	2	2	..
"	-	Mechanics' Institution	-	Shuttleworth, Sir J. P. K.	-	Sutherland, J.	-	Shore, T. W.	-	60	48	..	12	10	5	..
"	-	Grammar School	-	Shuttleworth, Sir J. P. K.	-	Sutherland, J.	-	Shore, T. W.	-	50	50	..	..	..	..	..
Bury	-	Athenaeum	-	Hildyard, Rev. C. F.	-	Probert, T. W.	-	Wilkinson, T. T.	-	60	72	12	..	6	27	1 S.
Cambarne	-	British School	-	Smith, George	-	Pike, Walter	-	Spriggs, C.	-	21	31	10	..	4	3	..
Cardiff	-	Free Library	-	Davids, C. W.	-	Price, Peter	-	Rosen, C. Le Neve	-	56	42	..	14	11	24	..
Cheltenham	-	Bedford Buildings	-	Downing, James	-	Moore, H. J.	-	Noctuit, W. L.	-	145	146	1	..	25	40	1 B. 3 G.
Chester	-	Mechanics' Institution	-	Frost, Meadows	-	Harris, Rev. Jas.	-	Craister, W.	-	64	25	39	3	2	..	..
Chorley	-	National School	-	Stock, Rev. John	-	Paton, Rev. J.	-	Craister, W.	-	20	20	20	18	6	7	..
Citheroe	-	Mechanics' Institution	-	Dewhurst, Robert	-	Mercer, John, jun.	-	Gunn, W.	-	30	13	..	21	..	..	..
Congleton	-	Wesleyan Schoolroom	-	Hadfield, W.	-	Jackson, B.	-	Greenwood, A. T.	-	21	21	..	8	5	6	..
Cottesmore	-	National Schoolroom	-	Stuart, Rev. A. G.	-	Miles, Rev. S.	-	Cattell, Thos.	-	14	23	..	9	8	7	..
Crewes	-	Mechanics' Institution	-	Ramsbotham, James	-	Stubbs, Thomas	-	Craister, W.	-	24	15	..	9	8	7	..
Croydon	-	Literary Institution	-	Carpenter, Dr.	-	Price, G. N.	-	Jones, T.	-	23	23	23	..	9	..	..
Darlington	-	Science Class	-	Pease, Henry	-	Swainburne, T.	-	Sullivan, M.	-	13	12	..	..	1	..	..
Darwen	-	Mechanics' Institute	-	Graham, Rev. P.	-	Bradbury, A.	-	Weatherill, Robt.	-	29	29	29	..	2	..	..
Deplford	-	St. John's School	-	Money, Rev. C. F. S.	-	Earland, Thos.	-	Farncomb, E.	-	18	18	..	..	5	..	..
"	-	St. Paul's School	-	Leves, S. S.	-	Marchant, T. W.	-	Badrutidge, W.	-	40	40	..	..	24	..	..
"	-		-		-		-	Dorrell, C. F.	-			..	..			..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1896.	1897.			1896.	1897.	1896.	1897.
Denton	Mechanics' Institution	Nicol, Rev. W.	Bailey, F.	Hurst, W.	..	10	10	..	..	1	..	..
Derby	The Grammar School	Bennet, J.	Longdon, F.	Greaves, C. A.	..	10	10	..	..	2	..	..
Droyliden	Educational Institution	Ashworth, George	Blackburn, Jas.	{ Spriggs, C. Richardson, H.	69	37	..	32	20	23	..	..
Eastington	National School	Peters, Rev. Thos.	Hooper, C. H.	{ Pullen, M. Wilcox, E.	15	11	..	4	4	6	..	1 G.
Eastwood	Wesleyan Day School	Ford, G.	Warner, E.	{ Pullen, M. Moses, H. W.	16	16	..	8	5	1	..	..
Eastwood	Mechanics' Institute	Wright, F. B.	Plumtree, Rev. H. W.	Forbes, D. M.	23	20	..	..	..	4	..	..
Elland	Mechanics' Institute	Farrar, J.	Kaye, Uriah	{ Jarmain, G. Parke, G. H.	23	20	..	3	7	13	..	..
Exeter	Literary Society	Head, R. T.	Tucker, J. T.	{ D'Urban, W. S. M. Perkins, P. P.	44	37	..	7	..	15	1 B.	..
Falmouth	National School	Carne, W.	Hooper, W.	{ Sheppard, Wm. Shaw, H. C.	13	14	1	..	1	1	..	..
Glossop	Littlemoor & Howard Town	Atkin, Thomas	Wood, Samuel	Geo. William	23	19	..	3	1	1	..	..
Gloucester	Mechanics' Institute	Washbourn, B.	Fowler, Hugh	Jeffery, Walter	45	46	1	..	21	4	..	..
Grantham	Science Class	Burbridge, J. F.	Madison, Rev. G.	Cockman, A.	..	24	24	..	..	4	..	..
Greenwich	Literary Institution	Purvis, Prior	Jordan, C. H.	{ Sullivan, M. Jones, Thomas	26	50	24	..	17	22	..	..
Guisborough	Mechanics' Institution	Chaloner, Thomas	Webster, T.	{ Griffiths, J. A. Weatherill, R.	25	7	..	18	7	1	..	..
Hallifax	Working Men's College	Ackroyd, Edward	Gibb, George	Jarmain, George	15	17	2	..	4	3	1 S.	..
Hastings	The Institute	Thompson, Rev. R.	Binns, John	Shore, T. W.	29	19	..	10	5	4	..	..
Heywood	Mechanics' Institution	Smith, Mark	Fairbrother, G.	{ Spriggs, C. Richardson, J.	23	33	9	..	1	23	..	..
Huddersfield	Mechanics' Institution	Smith, A. M. A.	Rhodes, Geo. W.	{ Lightbown, J. H. Jarmain, George	26	16	..	10	4	3	..	..
Hull	Nautical Schools	Whitaker, Thomas	Wilson, Edwards	Scapling, Zebedee	79	73	..	6	96	96	{ 3 G. 1 S. 1 B.	3 G. 2 S. 4 B.
Hulme	Working Men's Institute	Aspden, Richard	Letch, Geo. V.	{ Richardson, J. Richardson, H.	11	46	35	..	..	8	..	..
Huntingdon	Walden's School	Ward, W.	Vesey, Rev. F. G.	{ Jones, T. Pascoe, John	..	20	20	..	..	7	..	..
Hyde	Mechanics' Institute	Hibbert, E.	Lawton, Thomas	Geo. W.	47	69	13	..	9	21	..	..
Kettering	National School	Lindsay, Rev. H.	Elared, George	{ Fallows, J. H. Shurges, Wm.	..	21	21	..	..	16	..	..
Kingsbridge	Science Class	Davis, Rev. J. W.	Thomas, W. J.	Partridge, Hy.	..	12	12	..	..	7	..	..

Kinver	National Schoolroom	Wharton, Rev. G.	Bolton, Thomas	Pecker, M. W.	24	34	10	7	8	..
Lancaster	Mechanics' Institution	Turner, Rev. Canon	Moore, J. D.	Prosser, W.	..	53	63	..	..	..
Leeds	Mechanics' Institution	Hole, James	Sales, H. H.	Ward, George	33	39	6	11	7	..
Leicester	St. Martin's School	Vaughan, Rev. D. J.	Jones, H. S.	Atkins, Edward	40	49	9	5	5	..
Lincoln	St. Margaret's School	Jones, Rev. T.	Pertwee, Rev. A.	Poyner, H.	..	5	5	..	..	..
"	Grammar School	Anley, W.	Nelson, Rev. H.	Crawley, Samuel	..	21	21	..	21	..
"	Training College	Mackenzie, Rev. H.	Blenkin, Rev. F. B.	..	..	44	44	..	4	..
"	Mechanics' Institution	Keyworth, J. E. H.	Everard, H.	..	..	23	23	..	..	..
Liverpool	Free Library	Samuell, E. S.	Gregson, S. L.	Birkenhead, E. H.	28	68	40	9	13	1 S.
Liverpool	Liverpool Institute	Samuell, C. S.	Sharpe, Charles	Adair, S.	..	90	90	..	15	..
Llanelli	Copper Works School	Nevill, C. W.	Davies, John	Jones, John	33	49	17	9	11	..
London	City Middle-class School	..	Wormell, Etch.	Davidson, E. A.	..	24	24	..	3	..
Bath Street	Sir Walter St. John's School	Jenkinson, Rev. J. S.	Bryant, W. J. D.	Martin, J.	..	63	63	..	45	2 B.
Battersea	Birkbeck Schools	Rogers, Rev. W.	Rhiza, George	Spinks, G. J.	..	130	11	16	15	1 B.
Bethnal Green	National School	Hansard, Rev. S.	Halliday, J.	Simpson, B.	29	53	23	13	15	1 G.
Chelsea	St. Mark's Practising School	Mayo, Rev. M. W.	Benham, Rev. W.	..	64	124	60	38	70	1 G., 1 S., 1 B.
Gt. Ormond Street	Working Men's College	Maurice, Rev. F. D.	Rawlins, Hy. E.	Dawe, C. S.	7	18	11	25	4	1 S.
Islington	Lower Islington Public School	Fleming, Rev. W.	Ross, John	Atkins, G.	104	109	5	..	35	1 B.
Kingsland	Kingsland and Dalston Institute	Aveling, Rev. T. W.	Hoskins, W. H.	Briggs, H.	45	36	..	9	1	1 B.
Lambeth	Borg's Schoolroom, Lambeth Green	Scotton, Rev. W.	Heller, T. E.	Bithell, R.	26	39	13	7	18	..
Leadenhall St.	City of London College	Whittington, Rev. B.	Maskell, Rev. J.	{Duckett, W. Griffiths, J. A.}	22	34	13	3	..	..
Polytechnic	Royal Polytechnic Institution	Mackenzie, Rev. C.	Cousens, J.	{Snelus, G. J. Coles, F.}	32	47	15	21	20	1 G., 1 S.
Chancery Lane	London Mechanics' Institution	Campbell, Hon. D.	Parry, H.	{Terry, B. Coles, F.}	17	10	..	7	..	..
Dock Street	Sailors' Home	Maude, Francis, Captain, R. N.	Webb, W. H.	Newton, John	..	256	256	..	..	..
Peckham	Upper and Middle Schools	Grog, E. A.	Hutchinson, T.	Tate, E.	..	346	346	..	23	..
Macotenfield	Modern Free School	Wartle, Thomas	Brooker, J.	Jackson, J.	..	36	..	23	..	..
Manchester	Oldham Road National School	Lindsay, Rev. T.	Gregory, John	Holl, Joseph	..	12	12	..	..	..
Manchester	Roby Educational Society's Rooms	Gallender, W. B., Jun.	Ellis, E. P.	Schofield, J.	13	31	18	1	6	..
"	Mechanics' Institution	Neill, Robert	Jarrett, Albert	{Angell, J. Mellor, J. Tomkins, E.}	398	239	..	149	58	2 S. 2 B.

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.		Increase.	Decrease.	Number of Prizes.		Number of Medals.	
					1886.	1887.			1886.	1887.	1886.	1887.
Manchester	Corporation Street	Smith, Rev. A. C.	Plant, John	Lightbown, J. H.	42	36	..	6	5	2	1 B.	..
Middlesborough	Church of England Institute		Donaldson, Rev. A. B.	Stead, W.	..	6	..	..	..	..	..	..
Middlesborough	Mechanics' Institution	Gilkes, Edgar	Taylor, Wm.	Weatherill, B.	9	8	..	1	..	1	..	..
Middleton	National School	Durnford, Rev. B.	Ward, Rev. C. B.	Wheeler, G. H.	17	23	..	5	5	13	1 G.	..
Nelson-in-Marsden	Lomeshaye Mills	Erry, W.	Waddington, J.	Clement, L.	36	27	..	9	13	21	..	1 B.
Newport (Mon.)	Athenaeum and Mechanics' Institution.	Graham, W., Jun.	Maynard, E.	Bush, James	23	16	..	7	4	18	..	..
Norton Heath	Church Street	Taylor, Joshua	Evans, George	Lightbown, J. H.	..	10	..	10	..	9	..	..
Newton Heath	Mechanics' Institution	Taylor, Joshua	Holt, Samuel	Jones, Thomas	16	12	..	4	8	..	..	..
North Ormsley	Church Institute	Pennyman, J. S.	Moylo, Rev. V. H.	Weatherill, Robert	10	7	..	3	2	4	..	..
Nottingham	Mechanics' Institution	Morse, Rev. F.	Thurlow, Richard	Stimpson, A.	75	35	..	40	19	4	..	..
Oldham	Glodwick Mutual Improvement Society's Rooms.	Robinson, John	Green, Jeremiah	Sissling, W.	..	30	..	30	..	17	..	..
"	Science and Art School	Platt, John	Bailey, Thomas	Aershow, T. Jun.	100	100	..	..	36	67	1 G. 1 S.	3 B.
"	Parish Church School	Schofield, James	Walters, Rev. W.	Mitchell, Thomas	13	19	..	19	..	..	..	..
"	Analytical Society	Fox, Rev. J. H.	Nuttall, William	Philip, J. P.	..	14	..	1	..	..	..	..
Padiham	National School		Warburton, Rev. P.	Mellor, James	..	18	..	18	..	2	..	..
Painewick	Free School	Gardner, W.	Skinner, J. W.	Shore, T. W.	12	10	..	2	15	2	..	..
Pendleton	Mechanics' Institution	Waterhouse, J.	Herrop, J.	Jones, Thomas	17	17	..	..	2	7	..	..
Pendleton	Pendleton Club	Armistage, B., Jun.	Armistage, B.	Slater, J. K.	..	35	..	35	..	..	..	..
Plumstead	Burrage Road School	McAlister, J. A.	Hammond, J.	Rowden, W. T.	57	62	..	5	46	67	1 B.	..
Plymouth	28, Buckwell Street	Eisk, Rev. J. E.	Widdake, T. H.	Shippam, C.	..	18	..	18	..	3	..	..
Plymouth	Science School	Radford, W.	Cawse, J. H. M.	Farlie, C. J.	124	154	30	..	31	63	1 S. 1 B. 1 S. 1 B.	..
Pontypridd	Navigation School	Hill, Richard	Cuning, W. B.	Higdon, A.	..	17	..	19	..	11	..	..
Portland	Science School	Williams, D. W.	Basset, C.	Evans, H.	36	17	..	19	..	16	..	..
Preston	The Grove School	Clifton, George	Hill, Rev. Arthur	Rider, A. J.	..	15	..	15	..	3	..	..
Purleigh	School of Science	Jackson, C. R.	Dunn, James	Merrifield, J.	23	37	..	14	..	9	..	..
Rhodes	Science Class	Tamplin, Rev. G. F.	Larkin, Charles	Robotham, W.	20	28	8	..	7	15	..	1 S.
Rhodes	National School	Dunford, Rev. R.	Corbould, Rev. W. H.	Moffat, Wm.	..	23	..	23	..	1	..	..
				Birkenhead, E. H.	..	23	..	23	..	1	..	..
				Goffin, Robert	..	23	..	23	..	1	..	..
				Wheeler, G. H.	..	23	..	23	..	1	..	..

St. Helen's	-	St. Thomas's School -	-	Mocatta, Rev. W. A.	Monzie, W. J.	Bournes, Thomas	22	19	3	2	1	1 G.
St. Just	-	The Institution	-	Hadow, Rev. G.	Boyns, R.	Foster, C. Le Neve	17	25	8	4	7	..
Salford	-	Working Men's College	-	Pickup, Vasey	Plant, John	Alingill, T.	53	44	9	9	6	..
Salford	-	St. John's Hall	-	Mather, John W. D.	Richardson, G.	Law, E.	..	30	..	..	7	..
Slough	-	Mechanics' Institution	-	Cree, Rev. J. A.	Chapman, J.	Tomkins, E.	65	62	8	..	4	..
Stillington	-	Wesleyan School	-	Brown, T.	Dixon, J.	Dorrell, J.	..	19	..	..	..	..
Stockport	-	Mechanics' Institution	-	Leigh, William	Robinson, S.	Smithies, S.	31	39	8	13	15	1 B.
Stonehouse	-	The Institution	-	White, Rev. W. F.	Holland, Rev. P. E. S.	Davenport, T.	21	10	11	2	1	..
Stroud	-	Stroud Institute	-	Dickinson, S.	Gardner, H. F.	Vick, W.	45	63	13	12	13	1 S., 1 B.
Telworth	-	Waleson Day School	-	Moorhouse, Rev. J.	Gurney, N.	Macraill, I.	..	13	13	13	1	..
Torquay	-	School of Science and Art	-	Sheppard, A. B.	Weeks, C.	Vicars, Thomas	70	36	34	13	13	1 B.
Torquay	-	1, Spring Cottage	-	Harvey, John	Moyle, Charles	Pratt, W. N.	..	18	..	..	6	..
Walsall	-	Science School	-	Jesson, R.	Irvine, Rev. A. O.	Packer, M. W.	30	31	1	1	9	..
Wigan	-	Mining and Mech. School	-	Peggie, Rev. T. F.	Peace, M. W.	Birkenhead, E. H.	30	23	7	3	9	1 B.
Wolverhampton	-	Athenaeum Class	-	Iles, Rev. J. H.	Langley, J. N.	Packer, M. W.	..	12	..	..	1	..
Wolverton	-	Science and Art Institution	-	Mumford, A. L.	Meadley, J.	Harnett, Rev. F. W.	50	60	10	20	35	..
Woolwich	-	{ Mechanics' Institution, } Royal Arsenal.	-	Anderson, John	Keeble, W. D.	Burgess, Rev. S.	62	60	2	28	48	..
"	-	National School	-	Brown, Rev. H.	Wilson, James	Stone, W.	..	53	84	5	40	1 S.
Woolwich	-	St. Thomas' Parochial School	-	{ Robertson, Capt. } R. R. N.	Norman, J. H.	Duckett, W.	24	65	..	..	57	1 G., 1 B.
Yarmouth, Great	-	Navigation School	-	Null, H. R.	Cubitt, F. A.	Jones, E. S. L.	..	112	27	5	1	..
York	-	Popular Institution	-	Palmer, Rev. H. V.	Hall, Robt.	Brown, L.	139	120	26	9	3	..
SCOTLAND.												
Aberdeen	-	Mechanics' Institution	-	Matthews, James	Sinclair, J.	{ Beveridge, Dr. } Maver, D.	91	69	23	6	6	..
"	-	Navigation School	-	Cook, John	Kellas, J. F.	{ Ritchie, George } Jones, J. R.	..	254	..	..	3	..
Corsewall	-	Girls' School	-	Sturrock, Rev. G.	Houston, S.	Macomish, M.	13	26	13	9	14	..
Dundee	-	High School	-	Sturrock, John	Cumming, A. W.	Kennedy, John	62	57	5	11	14	..

List of Science Schools and Classes, &c.—continued.

Town.	Where held.	Chairman.	Secretary.	Teacher.	Number of Individuals under Instruction.	Decrease.	Number of Prizes.	Number of Medals.
					1896.	1897.	1896.	1897.
Glasgow.	Secular School	The Lord Provost.	Cunliffe, Rich. S. Lang, Gilbert.	Mayer, J. Mayer, Mrs. McLear, J. Lochore, J.	105	163	44	53
Inverness.	Andersonian University Science Class.	Dallas, W.	Galloway, G.	Bain, Robt. L.	..	327	..	23
Kilmarnock.	New Public School	Aitken, Rev. James	MacKay, John	Stevenson, James	..	20	..	8
Leith.	Navigation School	Paton, Walter	Thomson, Rev. J.	Dunn, H. S.	20	48	1	12
				Bolan, J.	213	200	..	5
IRELAND.								
Antrim.	Science Class.	Ferrard, M.	Wilson, D. M.	Savage, H.	..	43	..	6
Armagh.	Natural History Society's House	Brown, S.	Davidson, B. P.	Mills, L. G.	19	21	10	7
Athlone.	St. Mary's Schools	Handcock, R.	Berry, Rev. E. F.	James, M. H.	..	28	..	7
Bailieboro'.	Model National School	Dallon, G. T.	Simpson, A. J.	Doherty, J. J.	..	86	..	84
Ballycarry.	Science Class.	Davey, M. R.	Sinclair, Alex.	McGuffin, Robt.	..	7	..	2
Ballymena.	National School	Greene, Rev. S. J.	Lynch, Rev. J.	McCormick, J.	..	14	..	14
Ballymena.	Model School	Kowan, Rev. R. W.	Given, John	Shannon, A. F.	90	28	..	11
Banbridge.	National School	Kowan, Rev. R. W.	Lynch, Rev. John	Black, R.	..	18	..	11
Belfast.	Scarva Street National Sch.	Anderson, Rev. E.	Noble, John	Gillette, Jas.	..	28	..	11
Belfast.	Edgmont Street National School	Mullan, W.	Shepherd, W.	Broune, W. M.	..	13	..	6
Belfast.	Belfast Academy, Donegal Street	Lytle, John	Nesbitt, R.	McNeill, James	18	80	5	8
Belfast.	Fishernick Place Na- tional School	Mullan, W.	Shepherd, W.	Cleland, Robt.	..	28	..	14
Belfast.	Linen Hall Street	Mullan, W.	Shepherd, W.	Browne, W. M.	10	47	7	8
Belfast.	Model School	Mullan, W.	Shepherd, W.	Smeech, Rowland	23	55	14	..
Belfast.	Shankbone Street National School	Mullan, W.	Shepherd, W.	MacMillan, W.	..	36	..	..
Belfast.	Great George Street	Lytle, John	Nesbitt, R.	Messrs. Stevenson and Birkie.	83	68	13	1 B.
Belfast.	Crumlin Road	Lytle, John	Nesbitt, R.	Barrie, R.	..	23	..	..
Belfast.	Old Lodge Road	"	"	Miller, J. B.	..	16	..	..
Belfast.	Academy Street	"	"	Gray, T.	..	20	..	..
Belfast.	Royal Academical Institute	Mullan, W.	Shepherd, W.	McCreas, Dr. Hunter, J.	64	45	15	1 G.

[illegible]

TABLE showing the CLASSES in each of the preceding SCIENCE SCHOOLS, the SUBJECTS taught, and the NUMBER of STUDENTS in each Subject.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
			Practical Plane and Descriptive Geometry.	Mechanical and Machine Drawing.	Building Construction.	Elementary Mathematics.	Higher Mathematics.	Theoretical Mechanics.	Applied Mechanics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology.	Zoology.	Vegetable Physiology and Economic Botany.	Systematic Botany.	Mining.	Metallurgy.	General Navigation.	Nautical Astronomy.	Steam.	Physical Geography.
Abingdon	British School-room	23																							
Abercrombie	Mechanics' Institution	21																							
Alderley Edge	Day School-room	14	14	14																					
Almondsbury	King James's Grammar School.	23																							
Andover	Mechanics' Institution	47																							
Arwick	Wesleyan School	10	10																						
Ashey-de-la-Zouch	Mutual Improvement Society's Rooms	36																							
Ashton-under-Lyne	Mechanics' Institution	15	15	15																					
Bacup	Mechanics' Institution	49																							
Banbury	British School	30																							
"	Science School	30			4.																				
"	Laboratory	8																							
Barnsley	St. John's School	12	12																						
Birmingham	Midland Institute	106	13																						
"	St. Barnabas' National School.	45																							
"	Railway Works, Saltley.	59	53																						
"	Wesleyan Schools, Dud-																								
"	Matthew's Schools, Dud-																								
"	leston, Clarendon Church.																								
Blackburn	School of Art	55																							
"	Wesleyan School	9																							
"	Mechanics' Institution	16																							

ENGLAND.

Table showing the Classes in each of the preceding Science Schools, &c.—continued.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Glossop	Littlemore and Howard- town Mechanics' Institute	20																							20
Gloucester	Blue-coat School	44																							
Grantham	Science Class	24																							
Greenwich	Literary Institution	47	47	47																					
Guisborough	Mechanics' Institution	7																							
Halifax	Working Men's College	16																							
Healington	The Institute	18																							
Heywood	Mechanics' Institution	32	20	20																					
Huddersfield	Mechanics' Institution	13																							
Hull	Nautical Schools	73																							
Hulme	Working Men's Institute	48	17	17																					
Huntingdon	Walden's School	16																							
Hyde	Mechanics' Institution	57	13	37																					
Kettering	National School	16																							
Kingsbridge	Science Class	13																							
Kinver	National Schoolroom	30																							
Lancaster	Mechanics' Institution	56																							
Leeds	Mechanics' Institution	31																							
Leicester	St. Martin's School	41																							
"	St. Margaret's School	4																							
Lincoln	Grammar School	23																							
"	Mechanics' Institution	20																							
"	Training College	44																							
Liverpool	Free Library	68																							
"	Liverpool Institute	90																							

Table showing the Classes in each of the preceding Science Schools, &c.—continued.

Town.	Where held.	No. of individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
Padiham	National School	17																							
Painwick	Free School	10	16	16																					
Pendleton	Mechanics' Institution	16	16	16																					
Pimms	Pendleton Club	85																							
Pimms	Burrough Road School	60	60	60																					
Plymouth	28, Buckwell Street	17																							
Pontypridd	Science School	163	34																						
Portland	Science School	29																							
Preston	The Grove School	14																							
Purleigh	Avenham Institute	38																							
	School-room	27																							
Rhodes	National School	23																							
St. Helen's	St. Thomas' School	16																							
St. Just	The Institution	25																							
Salford	Working Men's College	60	10	10																					
	St. John's Hall	16	15	14																					
Sibford	Friends' School	11																							
Slough	Mechanics' Institution	52	52																						
Stillington	Wesleyan School	19																							
Stockport	Mechanics' Institution	37	10	15	5																				
Stonehouse	The Institute	11																							
Stroud	Stroud Institution	69																							
Tebworth	Wesleyan Day School	12																							
Torquay	School of Science and Art	12																							
"	1, Spring Cottages	21																							

Table showing the Classes in each of the preceding Science Schools, &c.—continued.

Town.	Where held.	No. of Individuals under Instruction.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
			Practical, Plane, Geometry, and Descriptive	Mechanical and Machine Draw- ing.	Building Con- struction.	Elementary Ma- thematics.	Higher Mathe- matics.	Theoretical Me- chanics.	Applied Meeha- nics.	Acoustics, Light, and Heat.	Magnetism and Electricity.	Inorganic Che- mistry.	Organic Chemis- try.	Geology.	Mineralogy.	Animal Physi- ology.	Zoology.	Vegetable Physi- ology and Eco- nomic Botany.	Systematic Bo- tany.	Mining.	Metalurgy.	General Naviga- tion.	Nautical Astro- nomy.	Steam.	Physical Geo- graphy.
Belfast	Bellinton' Street National School.	13	..	..	..	13	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Academy, Donegal Street	60	..	..	..	60	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Fisherwick Place National School.	23	..	..	..	23	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Linen Hall Street Model School.	47	..	..	..	38	13	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Stanhope Street National School.	35	..	..	..	35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Great George Street	63	..	..	..	..	..	..	..	33	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Crumlin Road	22	..	..	..	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Royal Academical Institu- tion.	35	..	..	..	..	..	..	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	National Model School	48	..	..	..	..	..	..	..	43	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Old Lodge Road	16	..	..	..	..	..	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Academy Street	20	..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Wolfhill Mill.	23	..	..	..	..	..	..	..	22	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	Maritime Model School	36	..	..	..	36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Carlow	Christian Brothers' School.	18	18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cardiff	Model School	49	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cardiff	Navigation School	23	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clifton	Maritime School	23	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Conber	St. Mary's National School	83	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cork	District Model School	17	..	..	..	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Drogheda	St. Mary's National School.	20	20
"	Whitworth Hall, Lawrence Street.	27

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Printed by **GEORGE E. EYRE and WILLIAM SPOTTISWOOD,**
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[10216.—300.—12/67.]



